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A PHYSICAL SURVEY

IN

GEORGIA, ALABAMA AND MISSISSIPPI,

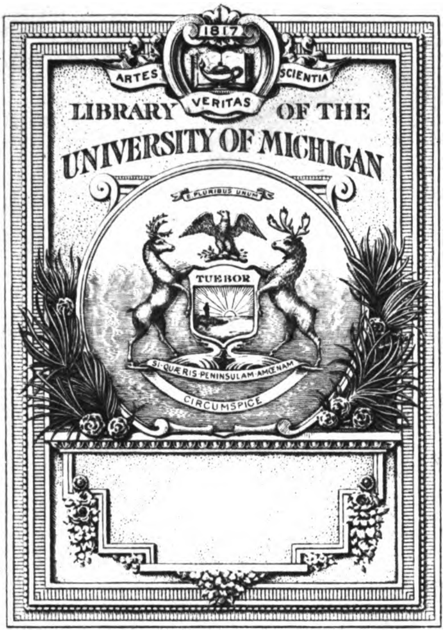
ALONG THE LINE OF THE

Georgia Pacific Railway.

BY

Messrs. CAMPBELL & RUFFNER.

E. F. Weeks, Printer and Stationer, 52 Cedar Street, N. Y.



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A PHYSICAL SURVEY

EXTENDING FROM

LANTA, Ga., across ALABAMA and MISSISSIPPI

TO THE

MISSISSIPPI RIVER,

Along the Line of the Georgia Pacific Railway,

EMBRACING THE

ology, Topography, Minerals, Soils, Climate, Forests, and Agricultural and Manufacturing Resources of the Country.

BY

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LEXINGTON, VIRGINIA.

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1883.

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PHYSICAL SURVEY.

During the Summer and Autumn of 1882 we made a reconnoissance of the belt of country extending due west from Atlanta, Ga., to the Mississippi River, giving special attention to its geologic structure, its minerals, soils, products and physical resources generally. The results of this examination, so far as they would be likely to interest the public, are herein given; and to these results we have added other and valuable information, obtained from the most authoritative sources. The reader may be surprised at the magnitude and variety of the resources of this singularly favored region, but probably cannot be more so than we were upon first learning the facts.

OUTLINE OF TOPICS.

For the purpose of making a clear presentation of our whole field of discussion, and of enabling our readers to fully appreciate the importance of its several parts and their bearings upon each other, we make the following subdivisions:

I. An outline of the Geology and Topography of the belt of country explored.

II. Mineral Resources.

A. The extent and quality of the Iron and Limestone Ores, and their proximity to each other.

B. Ores of Copper and Gold, Building Stone, etc.

C. Iron Mining, Manufacturing, etc.

D. Coal.—The Alabama Coal Field.

III. Climate.—Rainfall, Temperature and Health.

IV. Forests, with their present and prospective products.

V. Soils—their origin, character, culture and means of improvement.

VI. Population, Productions.—Comparative Statistics.

Appendices.

The Georgia Pacific Railway.

To adapt our discussion to different classes of readers, we shall first present the various topics, as far as their nature will permit, in a popular and practical form, suited to the mind of the unscientific inquirer, and to this end we shall make the plainest statement we can of the facts upon which we base our conclusions.

Then, in Appendices, scientific notes will be given on certain important topics, for the accommodation of those who may desire to make thorough inquiry into the several subjects of discussion. A Vocabulary of Technical Terms, a Geological Table, and some other matters of detail, are also supplied.

I.—GEOLOGY AND TOPOGRAPHY.

The geological history of any region of country, and an account of the physical agencies that have operated in modifying its surface features, bring into view the history of its topography. Hence these topics are naturally and most intimately associated. They are, moreover, very closely related to the mineral resources of the region, and to the degree of facility with which they may be utilized, as will appear in the sequel.

The reader should refer frequently to the accompanying maps.

The geology of the belt of country under review involves some notice of nearly all the great rocky formations that make up the mass of the American Continent. A brief sketch of these is necessary, therefore, to a clear conception of the general features of the region in question, and of the absolute and the relative positions of its extensive and varied mineral resources. In giving this sketch we shall, as far as is consistent with clearness, avoid technicalities* and adapt what we have to say to the mind of the general reader.

ARCHÆAN ROCKS, No. I.—The city of Atlanta stands upon that class of stratified rocks which geologists regard as the oldest of this

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***For the meaning of such technical terms as we may have to employ, see Appendix A.**

continent, and hence they are called "Archæan"—ancient; how ancient none can tell. They are by some writers divided into two groups, the lower called *Laurentian* (1 a); the upper called *Huronian* (1 b). (See Appendix A.) Others make four divisions, by subdividing the two above given. As the division into two classes will serve our present purpose and tend to simplify what we have to say, we shall adopt it.

Nearly all the rocks of the Archæan Age were originally deposited by water in horizontal layers, stratified, but have been greatly modified in structure by heat, or by heat and water acting conjointly under high pressure, and so have acquired a crystalline structure. This change is called "metamorphism," and hence the term "metamorphic" is frequently applied to these rocks. The term, however, is applicable in many places to formations of much more recent date.

The Archæan Rocks have been called "Azoic"—without life—under the supposition that they contained no traces of living beings, either plants or animals. But after traces of organic life had been discovered in some of them, the term "Eözoic"—the dawn of life—was applied to them to express that idea. The fact that they underlie what are known to be fossiliferous rocks wherever the two kinds come together (except where mechanical inversion has occurred), proves their relative, though not their absolute, antiquity. It shows that their history runs back into the past, far beyond that of any plant or animal that has left any distinct record of its career—such is the case, at any rate, so far as this region is concerned.

The Archæan are the country rocks all the way from Atlanta westward to the margin of Choccolocco Valley, in Calhoun Co., Ala. The two groups into which they have been divided are quite well characterized, both by their lithological and chemical peculiarities. The lower, or Laurentian group, consists largely of gneissoid granites, gneisses (often hornblendic) and hard schists. The Huronian group is newer, and is less highly metamorphosed. It consists chiefly of chloritic, micaceous and talcose schists and slates, with some interbedded gneisses. Some of its strata abound in hornblende, a ferruginous mineral which contains a considerable percentage of lime and disintegrates readily under the influence of atmospheric agencies—the iron oxide giving the resulting soil a valuable chemical constituent, as well as a deep red color, while the lime adds another important element of fertility.

Other strata abound in mica, hydromica, talc and quartz, and afford by their decay gray, sandy and micaceous clay soils.

Both of these groups are exposed in the cuts along the railway; but the Huronian constitutes by far the greater part of the surface rock. It is exposed all along the line from Atlanta to the Chattahoochee River. The erosive action of the river has cut through the upper beds, so as to expose the harder Laurentian rocks beneath at many points. At one of these points, a short distance west of the river, a quarry was opened from which building stone of good quality was obtained for constructing the abutments and piers of the railway bridge at that place.

As we approach Douglasville the hard gneisses and gneissoid granites make their appearance at numerous points, at some of which excellent granite has been quarried. The same rocks may be seen near Villa Rica, where they appear to underlie the hornblende schists and slates that carry the copper ores of that region, as well as the mica schists in which the gold-bearing veins of quartz in the same vicinity are found. From this point westward to the limit of the Archæan rocks in Alabama, the beds of the lower group appear occasionally, but not so frequently as they do in Georgia.

While these metamorphosed rocks were still in a somewhat plastic state, they appear to have been subjected to immense lateral pressure, acting from the southeast towards the northwest, by which they were bent upward and downward into waves and folds, and often partially inverted towards the northwest with the folds so pressed together as to give the whole series of strata a southeasterly dip. Sometimes, however, they have been left in a vertical position. In the cuts along the line of the railway many of these vertical and inverted folds are exposed to view. Not infrequently the strata are found in a nearly horizontal position, and sometimes raised in arches (anticlines), with corresponding depressions (synclines), but still the prevailing dip is towards the southeast.

The bearing or strike of the upturned edges of a greater part of the Archæan rocks is northeast and southwest. Such is the case along the Blue Ridge and Piedmont country from Maryland to Central Alabama.

Another feature which characterizes these ancient rocks is the prevalence of quartz veins of various sizes, and of shades of color ranging from pure white to a rusty brown. These veins have been apparently thrust into crevices among the stratified rocks; sometimes between the parallel beds, but more frequently cutting them more or less obliquely. In some places, as at Villa Rica and Arbacoochee, they carry gold in sufficient quantities to afford profitable mining.

Over large areas of country the less durable slates and schists have been disintegrated and washed away, leaving the quartz strewn in broken fragments, and in vast quantities, over the surface.

The topographical features here, as in all other regions of country, are determined in a great measure by the character and position of the geological formations. The gneisses and harder schists usually constitute the frame-work of the higher hills and mountains, while the softer slates and schists have been eroded by water and ice so as to leave sometimes deep ravines, and sometimes undulating valleys, between. The upturned folds and edges of the strata, generally running northeast and southwest, have given the same general trend to the principal ranges of hills and mountains, but these have been greatly modified by cross fissures that have opened the way for the smaller streams to cut channels for themselves in every direction; still the larger streams have a general southeasterly course, so long as they are confined to the area of metamorphic rocks.

A broad belt of country, extending from Maryland to Central Alabama, is based upon rocks of Archæan Age. It has the Blue Ridge Range in Virginia, the Unica in Tennessee, and the Blue Mountain in Georgia and Alabama, for its northwestern border. On the south~~west~~ its margin is approximately defined by the falls and shoals in the rivers at Washington, at Richmond and Petersburg, Va., at Raleigh, N. C., at Columbia, S. C., at Augusta, Milledgeville and Columbus, Ga., and at Opelika and Wetumpka, Alabama. An air-line from Milledgeville, passing near Atlanta and extending to the line of the Blue Ridge rocks, would intersect the Archæan belt in Georgia, and would show it to be about 100 miles in width.

The rocks have essentially the same lithological characters throughout this great Piedmont Belt, and give it very similar topographical features for several hundred miles; but in Georgia and Alabama these features are less rugged than they are in Virginia and North Carolina. Although the northwestern border of this belt is high and rugged in Northern Georgia, it becomes rapidly depressed after entering Alabama.

The metamorphic region which we passed over lies within the counties of Fulton, Cobb, Douglas, Paulding, Carroll and Haralson, in Georgia, and in Cleburne and the eastern part of Calhoun, in Alabama. It has an average elevation of about 1,000 feet above the Gulf of Mexico, and is remarkable for its healthful climate. It has pure water and much fine timber, and is well adapted to the culture of cotton, corn, wheat, rye and oats, and of all kinds of extra-tropical fruits.

The Chattahoochee and Tallapoosa are the most important rivers within this geological belt.

The geology of the great belt of Archæan rocks has determined not only its topograpical features, but also the character of its soils and mineral resources. These will be fully presented in other connections. For the present it is enough to say that this is the region of gold and copper mines, and of the rich sulphides now so extensively utilized for both their sulphur and copper in the sulphuric acid and fertilizer factory near Atlanta. It is, moreover, the region of granites and marbles, of slates and soapstones, of asbestos and corundum, and of mica and graphite.

THE LOWER SILURIAN FORMATIONS (NOS. 2 and 3).—Soon after passing the tunnel near Davisville, in Calhoun Co., Alabama, we enter the Choccolocco Valley, and pass abruptly upon rocks of a later date in geological history than those we have been heretofore considering. We are now in a valley resting on what are called Lower Silurian (or Cambrian) sandstones, limestone sand slates. It is true that these newer rocky beds appear to dip beneath the older metamorphic rocks that form the ridges along the southeastern margin of the valley; but this, which seems to be a reversed order, is most probably due to movements which may have occurred at the period known in the history of the rocks as the Appalachian Revolution.

The history of the rocks which are of more recent date than the Archæan, will be more clearly understood with the aid of a few explanatory remarks.

1. Stratified rocks are generally sea-bottom deposits, the material of which has come largely from contiguous land, although large quantities have also come from the abrasions of still older rocks on the bottom itself.

2. Sedimentary rocks (not metamorphosed) may be arranged under three general heads: (a) *Shales or slates*, formed from fine sediment, as clay and silt, indurated by long continued pressure aided by chemical agencies; when the successive layers are thin, the mass is said to be laminated. (b) *Sandstones*, formed of silica in particles of

various sizes—as sand and pebbles—mixed with more or less of foreign impurities, and cemented together with carbonate of lime, silica or oxide of iron. Sandstones may therefore be calciferous, silicious or ferruginous. The very hard silicious form, especially when considerably metamorphosed, is called *quartzite*. The presence of any considerable number of pebbles in rock of this class gives it the name of *conglomerate*. The higher sandstones and conglomerates of the coal age usually abound in scales of mica. (c) *Limestones*, made up of sedimentary or chemical deposits of carbonate of lime, or of consolidated masses of coral and shells. The wonderful variety of rocks of this class arises from the manner of their formation, their relative purity, and the metamorphic changes to which they have been subjected. A large proportion of the material of limestones has passed through animal organisms; hence clear, calm and warm sea-waters over bottoms of moderate depths, which are favorable to such organisms as corals and mollusks, are also favorable to the accumulation of limestones.

3. Sediments on a very gradually sloping and shallow sea-bottom, and exposed to the action of waves and tides, become water-worn and so assorted as to leave the coarser particles near the shore as "shingle," which graduates into finer material as sand, while the particles of clay and silt are carried out and deposited still farther from shore. When these several deposits are consolidated, the shingle becomes conglomerate, the sand becomes sandstone, and the clay and silt become shale. The same sea-bottom, at a still more remote point, may meantime be in a condition to accumulate limestone. Thus we readily account for the fact that the same geological formation may present a great variety of features, both of structure and composition, within the distance of a few miles.

4. Repeated elevations and depressions of such sea-bottoms, which have evidently been of very frequent occurrence in the Appalachian regions, gave rise to consequent changes in the conditions under which sediments were deposited—sometimes favoring the formation of sandstones, sometimes of shales, and sometimes of limestones; hence we find these different classes of rocks in alternating beds, one above another. In the meantime other conditions were brought about, at certain periods, favorable to a luxuriant growth of plants—the accumulated masses of which were subsequently converted into coal. Yet other conditions favored the extraction and deposition of iron ores and other minerals, and hence resulted the formation of their respective beds.

Changes such as these occurred, during a series of geological ages of unknown length, in a great inland sea which was once connected with what is now the Gulf of Mexico, on the south; limited probably by the Highlands of Canada on the northeast; having the Archæan ledges of the Blue Ridge for its southeastern border; and in all probability separated, in part at least, from the Pacific Ocean by the Rocky Mountain Range. This extensive sea, with Archæan rocks for its bottom and its shores, was the receptacle of the various materials that now constitute the surface rocks and soils of the Mississippi Valley.

THE PRIMORDIAL OR CAMBRIAN PERIOD (No. 2).—The earliest period of deposition on this sea-bottom was one favorable to alternations of shales and sandstones, in the upper portions of which formations are found some valuable beds of iron ores. This is what geologists have agreed to call the Primordial or Lower Cambrian period of geological history, and have noted it as No. 2. To its subdivisions, 2 a and 2 b, they have given the names *Acadian* and *Potsdam* epochs.

A few genera of marine plants and animals inhabited the sea during this period, while the dry land seems to have been destitute of organic life. We find along our line of exploration conspicuous representatives of this period in the sandstones and shales of Ladiga and Coldwater Mountains, near Oxford and Anniston, Ala. Its upper beds carry some valuable ores of iron and manganese.

CANADIAN AND UPPER CAMBRIAN (No. 3), are names given to the next period, which was one of great changes in the condition of the ocean. The rocks deposited during this period have been classified under three divisions; the lowest of which, or that immediately overlying the Potsdam, is called the *Calciferous* (3 a), from the leading characteristic of its beds in New York. This division in Alabama is made up chiefly of calciferous sandstones and shales, but carries some good deposits of limonite ores.

The middle division or group of strata is known as the *Quebec* or *Levis* (3 b), and is characterized by alternations of magnesian limestones (dolomites) with ferriferous shales. Hence it is sometimes called the *Dolomitic* group. During this epoch there were times when silica was abundantly deposited from the oceanic waters in porous and concretionary masses, called "chert," which forms some heavy and very durable beds accompanying the limestones in all the valleys of this part of Alabama. Evidences of vegetable and animal life in this epoch are by no means abundant. Its beds of shales and shaly limestones are the repositories of iron ores in great abundance and of superior quality, as we shall show presently.

The Chazy (3 c), or upper division of the Canadian period, is in Alabama one of the best sources of good limestone, much of which makes lime of excellent quality; and when used in blast furnaces, it has given entire satisfaction as flux. The ocean, during the Chazy epoch, was in a condition more favorable to animal life than it had been before, as is evinced by the greater abundance of fossils to be found in the limestones of this period.

These three epochs, the Calciferous, the Quebec and the Chazy, make up the Canadian Period—the great limestone period of ancient times.

We prefer to retain here, as elsewhere, the names and notation which have become *classic* in the literature of American Geology, and which are employed in our leading text-books on this subject.

THE TRENTON PERIOD (No. 4), which followed next in order, was one during which the sea water was in a condition favorable to the growth of corals and molluscan animals in great profusion. It was, therefore, a time for the formation of beds of fossil limestones. These beds are extensively developed in Virginia and farther north, but are inconspicuous in Central Alabama. Its two higher epochs, represented by the *Utica* and *Cincinnati* shales (4 b, and 4 c,) are scarcely represented here.

THE NIAGARA PERIOD (5 c)—named from the Falls of Niagara, where its rocky beds are conspicuous—with its three divisions, *Medina* (5 a), *Clinton* (5 b), and *Niagara* proper (5 c), has only one important representative here, the *Clinton Epoch* (5 b). This is the formation so remarkable as the repository of the famous fossil ores of Red Mountain. The deposition of alternate beds of shales and sandstones was here followed by a remarkable accumulation of fossil ore, interbedded in a heavy stratum of ferruginous sandstone; so durable as to constitute the back-bone of Red Mountain, and so prominent as to be readily recognized by its debris where the railroads pass through Red Gap, six miles east of Birmingham. (See geological Sec. No. IV.)

The next three periods, the Salina (6), the Lower Helderburg (7), and the Oriskany (8), though conspicuous in New York—and one of them, the Oriskany, excedingly rich in iron ores in portions of Virginia—are all wanting here. During the periods in which these formations were accumulating farther north, the ocean bottom in this region must have been so far elevated as for the time to have become dry land.

THE DEVONIAN AGE, with its periods, 9, 10, 11 and 12, has some representative beds in Alabama, but they are inconspicuous, and of but little practical importance in relation to the general subject of mineral resources.

THE CARBONIFEROUS AGE—the next in chronological order—is one of very special interest and importance, as will be shown in another connection. At present we shall simply locate it, with its general features and subdivisions, in its appropriate place in our brief historical sketch of the great mineral bearing formations and their relations to one another.

This was emphatically the age of plants. The sea, which still covered Central and Northern Alabama, swarmed with animal life, as indicated by the many fossil strata found among the rocks of this age. But its most important epochs were those in which the sea-bottom was so far elevated as to produce extensive brackish or fresh water marshes, where grew the luxuriant vegetation that has been converted into beds of coal.

The Carboniferous Age is divided by geologists into three periods, the oldest of which is called the Sub-Carboniferous (13); the next, the Carboniferous (14); and the latest, the Permian (15). As we have no evidence of the Permian being represented along our line of survey, we shall take no further notice of it in this connection.

Here again we shall avoid local nomenclature, except such as has become part of the language of geological science.

THE SUB-CARBONIFEROUS PERIOD (No. 13)—subdivided into two epochs, *Lower* (13 a) and *Upper* (13 b)—was one in which several alternations of shales, limestones and sandstones were deposited, with their characteristic fossils. It was also a time of bogs and marshes where plants grew in such profusion, within limited areas, as to form productive beds of coal—some of which have been mined in Northern Alabama and Tennessee, but none along our line of exploration near the Georgia Pacific Railway. The limestone formation of this period has proved valuable for furnace flux and for lime. Immediately overlying the limestone is a considerable bed of fossil chert and cherty sandstone, which carries with it some quite extensive deposits of iron ores; this formation is most conspicuous along the western margins of the Coosa and Cahaba Coal Fields, and the eastern margin of the Warrior Field.

THE CARBONIFEROUS PERIOD (No. 14).—The bottom division of this period (14a) is a coarse-grained sandstone or conglomerate, sometimes subdivided into two or more beds with intervening seams of coal, and hence has the name *Conglomerate Coal Group*. The main mass of sandstone, however, is usually called "Millstone Grit," and along our line of observation has two well-defined divisions; the lower, which is from 40 to 60 feet thick and is often a distinct conglomerate, has been used for making millstones—hence its name; the upper, 15 to 20 feet thick, is a very pure sandstone, and is valued as a "fire-stone" in the construction of furnace hearths. Above this we have alternate shales and micaceous sandstones with interstratified seams of coal, and occasional beds of black-band ores, indicating many changes in the condition of sea-bottom and coast-line.

In much of the Appalachian coal field two successive epochs have been distinguished as *Lower Coal Group* (14 b), and *Upper Coal Group* (14 c), both abounding in coal of fine quality.

THE APPALACHIAN REVOLUTION followed the age of coal, and resulted in changes of elevation and position among the rocky beds which are of the highest importance in relation to the development of their stores of mineral wealth.

During the long succession of ages intervening between the opening of the Primordial Period and the close of the Carboniferous, while thousands of feet of strata of various kinds were being built up one above another, frequent oscillations of level and other changes must have occurred in one great interior ocean basin—sufficient to cause the numerous lithological and fossil changes that mark the different periods and epochs. But with all this there was a good degree of parallelism (conformability) preserved among all the formations up to the close of the Carboniferous Age, at least so far as regards the middle and southern portions of the Appalachian Belt.

A period now arrived for a great continental upheaval to take place—not suddenly, perhaps, but with a steady constancy. The changes incident to this general movement constitute the great Appalachian Revolution. We discover the effects to be: 1st. General elevations of large areas, without any great disturbance in the original horizontal position of strata—as in the Warrior Coal Field, where the elevation amounts to about 400 feet above tide; 2d. Upheavals accompanied by *flexures*, *foldings* and frequent *inversions* of strata, as we shall find at points in Ladiga Mountain Range, and along the Birmingham Valley; 3d. Fractures and dislocations, causing the *faults* that are of such frequent occurrence in the valleys which separate the coal fields.

Whatever may have been the origin and nature of the force or combination of forces that brought about this Revolution, the resultant action must have been a heavy horizontal thrust of long continuance in a northwesterly direction. This we infer: first, from the northeast and southwest trend or "strike" of the larger portion of the flexures and folds, and of the upturned edges of ruptured or eroded strata; and second, from the fact that all or nearly all inversions of strata are towards the northwest, with a consequent dip towards the southeast. Although the Archæan rocks had been subjected to a like movement in an earlier period of their history, they must have been involved in this great Paleozoic disturbance, also.

Results.—The valuable results of these great upturnings of the different geological formations, in bringing to light the ample and varied mineral resources along the line of the Georgia Pacific Railway, will be more fully appreciated after a brief survey of the leading physiographic features presented at some important points in the belt of country traversed by the road west of the margin of the Archæan belt.

From Davisville Tunnel the railway runs in a southwesterly direction for 12 miles along the beautiful Choccolocco Valley, passing over the shales, sandstones, cherts and limestones of the Lower Silurian Age, among which we shall presently find limonite ores in great profusion. At Oxford, Calhoun Co., Ala., it leaves this valley and passes through the gap cut in Ladiga Mountain by Snow's Creek, a tributary of the Choccolocco. Here the sandstones and accompanying shales of the *Potsdam Group* (2 *b*) are exposed in well-defined arches. These rocks constitute the main body of the Ladiga and Coldwater mountains; the former on the east, and the latter on the west of the little valley in which Oxford and Anniston are situated. These ridges are two great stone-waves, between which we find the synclinal trough that holds the rich beds of iron ores mined to supply the Woodstock furnaces at Anniston.

The relative positions of the sandstones, limestones, ores, etc., will be easily understood by reference to the vertical sections I. and II., which are the representatives of an ideal plane, supposed to cut the whole series of rocky beds from a point a little north of Anniston to the margin of Cleburne County.

From Anniston the railway turns westward across the broad valley of the Coosa River, the country rocks of which belong, like those of the Choccolocco Valley, to the Quebec, Chazy and Trenton epochs. The durable beds of chert, heretofore mentioned as belonging to the formations of this age, sustain many rounded hills in all these limestone valleys, and at the same time cover their surfaces with broken fragments that sometimes conceal the limestones for miles.

The valley of the Coosa is a prolongation of the Great Silurian

THE TERTIARY AGE (No. 19) follows the Cretaceous Period in chronological order, and the debris of its rocks, together with widespread deposits of alluvium, cover the whole territory from the western margin of the Cretaceous to the Mississippi River, and far beyond. Of these more will be said in connection with soils and fertilizers.

A soft coal, called *lignite*—from its woody texture—is found in Mississippi. Prof. Hilgard speaks of it as "covering a large part of the northern half of the State." For many purposes these lignites have the value of good bituminous coals. They only await transportation to have their extent and value determined.

II.—MINERAL RESOURCES.

A.—IRON AND LIMESTONE ORES.

Nearly all of the geological formations described above contain valuable minerals of some kind; but of these we propose, under the present head, to consider only the *iron ores* and *limestones*, as these constitute the leading forms of material required for the manufacture of iron—at present the most important of the manufacturing industries in this belt of country.

Iron Ores.—These have already been incidentally referred to in several connections, but their great importance, and the conspicuous position they occupy as a source of revenue to the railway, and of prosperity to the country through which it passes, establish their claim to special prominence among the topics demanding more detailed discussion.

The ores employed in the manufacture of iron are of several varieties, all of which are represented along this line. They are generally characterized by external properties, so well defined that a practiced eye can readily distinguish the different kinds. Then there are a few simple tests which almost any one with a little ingenuity can apply, and which aid the eye in determining the several varieties.

All the varieties may be embraced in four general classes, distinguished from one another by chemical composition, as well as by physical properties. They are, (1) *Magnetite*, or Magnetic ore; (2) *Hematite*, Red and Specular ores; (3) *Limonite* (Brown Hematite; (4) *Siderite*, under forms of Spathic, Clay, Iron-stone and Black-band ores—different forms of carbonate of iron. There are many other compounds containing iron, but these four classes embrace all the ores commonly worked for the metal. Pyrite or Iron Pyrites is sometimes classed with iron ores, but is only employed as a source of iron when the sulphur has been first burned out, and the iron oxidized, in the manufacture of sulphuric acid. The residue makes an iron of only inferior quality.

(1.) *Magnetite* has the property of magnetic attraction—hence its name. When a mass of it possesses at certain points the power of severally attracting and repelling the opposite poles of a compass needle, it is a *lodestone*.

Fragments of this ore, as we find them exposed to the weather, resemble limonite in general appearance, but are usually more angular in shape, on account of superior hardness. Freshly broken surfaces of this ore (if pure) are darker than those of limonite, and the mineral retains its dark color when pulverized. Impure specimens, however, give a dirty brown powder. Small particles of it are always attracted by a magnet.

Absolutely pure magnetite consists of 72.4 per centum of metallic iron, and 27.6 of oxygen. It is the richest of all the ores of iron, but is often damaged by the presence of titanium, which, if present in considerable quantities, makes iron or steel hard and brittle. Sulphur, too, is sometimes present in injurious quantities. This ore is most commonly found among metamorphic rocks, but particles of it often occur in hematite and limonite ores; also with manganese.

(2.) *Hematite* gets its name from the blood-red color of its powder. When it occurs in crystalline form, its surfaces are iron-black and brilliant, and it is called *specular ore;* when in fine bright scales, it is *micaceous ore.* We find examples of red hematite in the ore of Red Mountain, and in the dye-stone of East Tennessee and Southwest Virginia.

In its purest condition, hematite contains 70 per centum of iron and 30 of oxygen. A simple test for hard lumps is to scratch them with a file or knife, when they will give a clear red powder. A small fragment heated in a cavity on a piece of charcoal becomes magnetic.

3. *Limonite,* or *Brown Hematite,* is the most abundant and most widely diffused of all the iron ores in this country. It is found sometimes in extensive beds, sometimes in pockets of limestone rocks, and sometimes in broken lumps mingled with other minerals. Its structure is usually more or less nodular; the nodules are frequently fibrous internally, and are called "needle-ore." The clay ore, or wash ore, is in small particles mingled with clay, which has to be separated by washing to render the ore pure enough for the furnace. An absolutely pure sample of limonite consists of sixty per centum of metallic iron, combined with 25.6 of oxygen and 14.4 of water. The water is easily expelled by roasting. A fragment of it heated in a cavity on charcoal, with a blow-pipe or otherwise, becomes magnetic. Lumps exposed to forest fires are similarly affected—sometimes to such extent as to disturb a surveyor's needle.

Bog Ore is an impure limonite, accumulated from ferruginous waters in low marshy grounds, and is usually mingled with clay and sand.

4. *Siderite* is carbonate of iron; it is called "spathic ore" when crystallized, "clay iron-stone" when in gray nodules or masses with a brown coating, and "black-band" as we find it associated with coal. This last has a slaty structure, and a dark brown or black color—due to the presence of carbonaceous matter.

The purest form of carbonate of iron (Siderite) occurs in crystals containing 48 per centum of metal, and 52 of carbon and oxygen united. Ores of this class, however, as clay iron-stone and black-band, rarely yield as much as 40 per centum of metal; but they are reduced with great facility in the furnace, and afford a valuable admixture to aid in the reduction of the more refractory ores.*

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* For the theory of the origin of different kinds of ore, see Appendix C.

IRON ORE AND LIMESTONE REGIONS.

1. The Archæan Region, above described as extending from Atlanta, Ga., to the margin of Choccolocco Valley, in Alabama, is that in which the specular and magnetic ores are most commonly found. Some favorable indications of both varieties have been discovered near the line of the Georgia Pacific Railway.

Mr. N. P. Pratt, one of our assistants, collected for the Boston Industrial Exposition a number of fine specimens of both magnetic and specular ores from Douglas, Paulding and Haralson counties, in Georgia, and from Cleburne and Talladega counties, in Alabama.

Near the eastern margin of Haralson County we found, in the neighborhood of the Hughes copper mine, a vein of magnetite of fine appearance as to quality, and with good surface indications as to quantity. Then, on the road leading from Villa Rica to Buchanan, and about 2 miles from the latter place, a bed of specular ore of the micaceous variety crops out; as far we could ascertain without digging, it is about 3 feet thick. This bed is worthy of attention.

Pyrite is found in large quantities among the metamorphic rocks, and will receive appropriate notice in connection with the subject of copper ores and the manufacture of sulphuric acid.

2. Choccolocco Valley claims attention as a distinct ore region. It is traversed by Choccolocco Creek; and is bounded on the southeast by the metamorphic ridge to which Prof. Tuomey, in his Second Report, gave the name "Choccolocco Mountain"—a prolongation of the Blue Ridge of Virginia; and on the northwest by the Ladiga Range, which separates it from the little valley in which Anniston is situated. The Georgia Pacific Railway enters Choccolocco Valley at the western terminus of the Davisville Tunnel, 86 miles west of Atlanta. The valley is here about 3 or 4 miles wide, and is underlaid by limestones, slates and sandstones of Lower Silurian age, as already stated in our geological sketch. The railway traverses this valley from the tunnel somewhat obliquely, but approximately parallel with the creek for 12 miles, and emerges from it near Oxford, where it passes into the Anniston Valley.

The geological structure of Choccolocco Valley is somewhat peculiar, but is most favorable for bringing its ores within reach of the miner. By reference to the vertical section, No. I, it will be seen that the strata which contain these ores are low down in the geological series, and were once buried far beneath overlying beds, but have since been uplifted, broken and partially washed away. It will also be seen that "faultings" have occurred along both sides and in the middle of the valley, by which the Potsdam sandstones, with the higher beds that rest upon them, have been ruptured and partially tilted towards the southeast. Thus, subordinate ridges have been formed, bearing limestones and ores on their southeastern slopes.

The ores of this valley are exceedingly rich and abundant, but have hitherto lain untouched in their original beds for want of the transportation and capital necessary for their utilization. The comparative ease with which they can be mined; their proximity to good furnace sites along Choccolocco Creek, which furnishes ample supplies of water at all seasons; the abundance of limestones near at hand; the presence of extensive forests that can be utilized for making charcoal, and the facilities for transporting coal, which are now assured—all contribute to make this a most attractive region for those who have capital and enterprise to invest in the manufacture of iron.

We visited several localities which will serve to demonstrate the abundance and value of the ores in this region.

(1.) Near White Plains, in Township 14, Range 9, E., Sec. 27, about 6 miles northeast of the Georgia Pacific Railway, there are several points at which surface boulders and outcropping ledges of ore are shown by citizens of the neighborhood—giving favorable indications both as to the quantity and quality of the ore.

(2.) At Iron Gap, between the railway tunnel and Choccolocco Creek, are abundant exposures of limonite. The ridge cut at this point is one of the uplifts of Potsdam sandstone mentioned above, and represented in geological section No. 1.

(3.) On the lands of Mr. Pendergrass (Township 16, R. 9, Sec. 2), and of Rev. Scott, adjoining, about 2 miles northeast of Davisville, and very near the line of railway, there are fine displays of ore—both as floating boulders and as ledges in place. The same lode extends into Dr. Bowling's place, a little farther southeast, and promising beds have been exposed at several points in the immediate vicinity of the village.

As we explored the valley still farther towards the southwest, we found near De Armenville a very extensive outcrop of limonite ore on one of the southeastern spurs of the Ladiga Range, on land belonging to Mr. Joseph A. Jones, of Oxford. Here the outcrop is a bold one, and fragmentary ore abundant. There are many other points along this valley where surface indications are favorable, though not so conspicuous as those mentioned above; some of them will doubtless lead to valuable sources of ore.

When the branch road from Alabama Furnace in Talladega County, designed to intersect the Georgia Pacific Railway, has been built, it will traverse a portion of this same ore belt, and will undoubtedly lead to the opening of ores at points to which little attention has been given.

Limestone.—The limestones of Choccolocco Valley are exposed to view at many points along the streams. The blue variety, of good quality, has been quarried for lime a short distance northwest of White Plains. Then again, near the point at which the railway crosses Choccolocco Creek, on the land of Mr. J. L. Hughes (T. 15, R. 9, E., Sec. 24), we examined a bed of grayish-blue stone of fine appearance. The same rock is found at many other points along the valley. We may, therefore, conclude that it exists here in abundance—a large proportion of it sufficiently pure to be employed as flux in blast furnaces.

3. ANNISTON VALLEY, a branch of the great Silurian Valley of the Coosa, introduces us to another extensive ore region. Anniston, where the Woodstock Company's furnaces are in active operation in the manufacture of charcoal iron, is at the junction of the Georgia Pacific Railway with the Selma, Rome & Dalton Railroad.

The region near Anniston is among the best ore fields in Alabama (see geological section, No. II). The ores that supply the furnaces are mined on a large scale on both sides of the valley. In some places they occur in boulders and fragments of every size, from those weighing several tons to others no larger than a pea, and are mingled with clay, sand and water-worn pebbles, in such a way as to indicate that they have been subjected to the action of Quaternary Drift. They appear, however, to have been moved but a short distance from their original bedding, as is inferred from their geological origin and the fact that they are but little water-worn, while the well-rounded boulders and pebbles of hard sandstone have evidently been brought from more distant points. At other places the ore beds are "*in situ*," as illustrated by Allen's mine, on land adjoining the Woodstock property, where the ore is imbedded in shale, apparently of the Quebec epoch (3 b).

The Pine Grove ore bank, 2 miles west of Anniston, owned by Mr. Lloyd, is leased by the Woodstock Company on royalty, and is at present worked on quite a large scale for consumption in the Company's furnaces. The mining is done on the northern slope of a Primordial ridge, which runs nearly east and west, and is an arm of Coldwater Mountain. The ore is in masses of varying size, most of which have the appearance of being fragments of what was once a continuous stratum (or vein, as the miners call it), and some of which weigh many tons. They are still in somewhat continuous lines, but bear marks of having been partly displaced from their original bedding. These masses of ore are now in the singular condition of being enveloped in material consisting of fine and coarse sand, mingled with numerous water-worn pebbles of various sizes—apparently the result of drift, but possibly of the breaking down of a coarse conglomerate.

The mining here is comparatively easy and inexpensive. The deposit of ore along the flank of the ridge has been traced for several miles, thus indicating a very large quantity.

This belt of iron-bearing strata has some interesting developments at points northeast of Anniston, and near the line of the Selma, Rome & Dalton R. R. For example, on the lands of Dr. Glover and others, near Weaver's Station, we found some openings of limonite in the Quebec shales; and, near the crest of the same ridge, mining has been done to some extent, but evidently in an older geological formation than that near the base of the ridge; most probably in Calciferous (3 a) strata, possibly in upper Primordial (2 c). All these promise good results from future mining.

Associated with these lowest ores is a bed of manganese ore, the extent of which has not been determined, but it is in the same range as the manganiferous ores successfully tested at Woodstock Furnace in making *Spiegeleisen.*

Southwest of Oxford, in fact within the limits of the town, the Anniston and Choccolocco ore belts coalesce and extend into Talladega County, where they furnish ample supplies of material for the Alabama Furnace, which is now making charcoal iron of good quality.

The following analyses will serve to illustrate the quality of the ores of this region. They are from banks in T. 18, R. 6, E., a few miles southeast of Alabama Furnace, and will serve as general types of the limonite ores of this extensive belt:

ANALYSES OF LIMONITE ORES.

PERCENTAGE COMPOSITION.	No. 1.	No. 2.
Combined water	11.86	11.52
Silicious matter	7.58	11.71
Ferric Oxide	77.54	68.93
Alumina	2.07	3.59
Manganese Oxide	....	3.77
Lime	0.07	0.10
Magnesia	0.63	0.05
Phosphoric Acid	0.29	0.13
Sulphur	....	....
Undetermined and loss	0.59	0.20
Metallic Iron	58.28	48.25
Phosphorus	0.13	0.06

ANALYSES OF LIMESTONES.

The four geological formations to be relied upon for the greater part of the best limestone available for lime, and for use in furnaces, are the Quebec, Chazy, Trenton and Sub-Carboniferous. The following table represents analyses of samples from each of these formations. [From State Reports.]

PERCENTAGE COMPOSITION.	Quebec.	Chazy.	Trenton.	Sub-Carboniferous.
Carbonate of Lime	55.35	86.72	90.60	93.40
Carbonate of Magnesia	34.58	6.31	6.74	0.32
Silicious matter	7.75	5.32	2.13	5.32
Alumina and Ferric Oxide	1.48	1.56	0.33	0.79
Water and loss	0.84	0.26	0.11	0.10

No. 1 is a well characterized dolomitic limestone, but has been successfully used for furnace flux.

MARBLE.

The following are analyses of two specimens of *marble* from Taylor's Mill, Talladega Co., Alabama. No. 1, is white crystalline; and No. 2, blue crystalline marble.

PERCENTAGE COMPOSITION.	No. 1.	No. 2.
Carbonate of Lime	95.25	94.40
Carbonate of Magnesia	0.62	0.41
Silicious matter	2.95	4.65
Alumina and Ferric Oxide	1.15	0.75

These marbles are remarkable for the small quantity of magnesia they contain.

In going westward from Anniston towards the Coosa River, we find much of the surface of the country occupied by gravelly ridges, the general trend of which is northeast and southwest—coinciding with the strike of the stratified rocks. These hills rest upon beds of limestone, as indicated by the numerous round sinks (pot-holes) found on their surfaces, and by the many exposures of limestones along the valleys eroded by the contiguous streams. Along these valleys and on the adjacent slopes, which have been stripped of their cherty coverings, appear the rich red soils produced by the disintegration of the underlying ferruginous shales and limestones. In these red soils are seen many indications of ore deposits similar to those in the neighborhood of Oxford and Anniston. Examples may be found in Township 16, Ranges 5, 6 and 7, East.

On the lands of Dr. Anderson, Mr. Nicholson, and others, in Calhoun Co. (T. 16, R. 7, E.), many favorable surface indications of limonite ores are found. Then, farther west, in the northern part of Talladega Co., Range 6, not more than one or two miles from the line of the Georgia Pacific Railway, abundant bloom of ore appears. Similar indications are also seen in Range 5, Sec. 8.

Farther south, but still nearer the line of the railway, at numerous points between Oxford, Calhoun Co., and Eden, St. Clair Co., evidences of extensive deposits of iron ore of Quebec Age appear, awaiting transportation, capital and enterprise for their development.

Limestone.—The limestone for flux at the Woodstock furnaces is hauled 4 or 5 miles on wagons, from a little valley (an offshoot of the Coosa Valley) which runs from the neighborhood of Weaver's Station, up a small branch of Cane Creek, between two ridges of the Ladiga range. The quarry is in a mass, apparently, of Quebec and Chazy limestone caught as a synclinal fold between the two ridges, as seen in geological section No. I. The beds are considerably metamorphosed, but the position of those from which the rock is quarried seems to put them in the Chazy formation (3 c), though the fossils were too obscure to be determined.

The expensive hauling of this limestone for so great a distance, and across a ridge of considerable elevation, will be rendered unnecessary by the completion of the Georgia Pacific Railway, which traverses both the Silurian limestones of the Coosa Valley and the Sub-Carboniferous limestones of the Coosa and Cahaba coal fields. From these sources abundant supplies of fluxing material can be obtained, of excellent quality and at very moderate cost. One of the best limestone areas between Anniston and the Coosa River is the valley of Blue Eye Creek, and in some of its branches. This valley also affords some excellent sites for furnaces, with good supplies of water.

West of the river, two miles from Coieman's Ferry, in T. 16, R. 4, E., Sec. 33, abundant bloom of limonite ore appears on a cherty ridge belonging to Mr. Coleman; ore apparently good, but no beds opened. This ridge is geologically above the general horizon of the ores of this region. A little farther west is another deposit, in the ferruginous shales of 3 b, not far from the line of fault where the Lower Silurian limestones are brought up to the level of the Sub-Carboniferous strata, on the eastern margin of the Coosa coal field.

4. COOSA AND CAHABA VALLEYS.—The Sub-Carboniferous Period was iron-producing during a portion at least of its continuance. Overlying the limestones of this period, there is, in both the Coosa and Cahaba fields, a considerable stratum of chert and cherty sandstone, in which beds of limonite ore have been accumulated. As an example of this we refer to Daughdrille's Ridge, a short distance north of Broken Arrow Creek, in St. Clair county, the northwestern face of which is an outcrop of Sub-Carboniferous limestone, full of characteristic fossils and estimated at about 150 feet in thickness. The limestone is covered by a bed of shale, and the whole crowned with a thick stratum of crinoidal chert and cherty sandstones, all dipping—at different points along the ridge—from 35° to 45° southeast. The southeastern slope of the ridge is covered with fragments of chert and cherty sandstones, mingled with floating limonite ore, thousands of tons of which could be gathered up from the surface within a short distance. Daughdrille's Ridge may be taken as a type of a line of broken ridges extending for a long distance towards the Southwest, and consisting, throughout the whole extent of our observations, of beds of Sub-Carboniferous limestone, shale and chert, all dipping towards the Southeast at angles varying from 30° to 50°.

Near Eden (T. 16, 3 E., Sec. 34) this limestone ridge is cut into several short ridges, one of which, a little way southwest of the railway line, is strewn with abundant fragments of iron ore and crinoidal chert, like those of Daughdrille's Ridge. The shales between the limestone and chert have greatly thinned out at this point; but the dark shales overlying the chert are, perhaps, heavier than they are at points farther north. The geological structure at this place is illustrated by Section No. V. It will be seen that the Sub-Carboniferous strata have been lifted up on one side, and the newer Carboniferous thrown down on the other side, of a crevice—producing a *fault* that causes the newer beds to appear to dip beneath the older. The Section is a copy of what may be seen in some of the gaps that have been cut through the ridges near Eden, by the railway and some small streams.

Passing farther westward into the valley of the Little or East Cahaba River we find, as stated in our geological sketch, an up-lift of Lower Silurian limestones, shales and cherts, forming a valley (from two to four miles wide) which separates the Coosa and Cahaba coal fields. It is limited along its northwest margin by a fault or slip which has brought the Silurian limestones, etc., up to the level of the highest coal-bearing strata of the Cahaba coal field; thus causing formations of widely separated geological ages to abut against each other, or, in some places, making the newer coal rocks apparently dip beneath the older limestones. (See geological section No. III.)

On examining the southeast margin of this valley, we found the Silurian limestones and the overlying Sub-Carboniferous strata, with a few hundred feet of intervening beds of shales and sandstones apparently of the Clinton epoch, all in their normal order of superposition. These formations all dip to the southeast, and pass beneath the higher Sub-Carboniferous sandstones and shales, and the overlying Millstone Grit—which ranges from 80 to 100 feet in this region, and constitutes the chief frame-work of Coosa or Bald Rock Mountain.

This is another region of iron ores, limited, it is true, but not unimportant. On the land of Mr. Pool (T. 17, R. 1. W., S. 36), on the crest of what is locally known as Pine Ridge, a mine of limonite ore was opened, and worked to some extent in a neighboring bloomary, during the late war, and is reported, by those who were engaged in the work, to have made bar-iron of good quality. This ore is found in rocks of No. 3, and gives indications of being in abundance.

About 6 miles south of the point at which the Georgia Pacific Railway crosses the Little Cahaba, we examined an extensive bed of limonite ore on the southeastern slope of what is locally known as Oak Ridge—a long line of hills (once a continuous ridge) composed of Sub-Carboniferous limestone, resting upon the beds of shale and sandstone of the Clinton epoch mentioned above, and overlaid by the same crinoidal chert so often mentioned as the repository of limonite ores. Here much of the cherty bed is really a cherty sandstone. The ore in it is very massive, and was opened and mined at several points, during the war, sufficiently to demonstrate its great abundance. It is said to be owned by the Sloss Iron Company, of Birmingham.

Near Moody's Cross-Roads the Quebec limestones and shales come to the surface, and give evidence of carrying considerable quantities of iron ore—samples of which are strewn over the surface of a field in front of Mr. Moody's house. North of this point is a continuation of the Sub-Carboniferous limestone ridge mentioned above, with some evidences of ore upon its surface.

Overlying the Millstone Grit, a bed of limonite ore crosses the wagon road near the crest of Coosa Mountain, at Thompson's Gap. Traces of the same bed have been found in similar relations in other localities. It may prove to be valuable at some future time.

Limestones.—The iron ores that border the coal fields, not only have an abundant supply of fuel near at hand, but have also, within a stone's cast of them, limestones in great abundance, and of quality well suited for furnace flux. The Chazy (3 c), Trenton (4 a), and upper Sub-Carboniferous (13 b) limestones are the purest in this region and are, therefore, the best for use in the furnace. The Chazy and Trenton lie along the public highway, and on several of the cross-roads within convenient distance of the railway, for several miles, as it traverses the valley. The line of Sub-Carboniferous ridges along the eastern side will furnish an indefinite quantity of stone, similar to that which is now quarried near Trussville and used in some of the Birmingham furnaces.

5. THE BIRMINGHAM VALLEY.—The Silurian valley in which Birmingham is located, and the Red Mountain ridges which border it in part on both sides, have been already referred to as constituting one of the great ore-fields of Alabama, and as embracing two of the geological formations noted for the quantity and quality of the ores they yield. (1). The lower shales and limestones of the valley, as heretofore stated, are of the same epoch, (3 b), as those from which the ores for the Woodstock and Alabama Furnaces are obtained, and carry with them at many points the same grade of ores. (2). The other ore-producing formation belongs to the Clinton epoch (5 b), and characterizes the celebrated Red Mountain. Its geological position has been already given in our historical sketch of the several important periods. (Section No. IV). Practically, it is noted as the

repository of extensive and well characterized beds of lenticular and fossil ores of superior grade, both as to richness and purity. These ores form a noted feature of the Clinton group, all the way from Pennsylvania, through Virginia and East Tennessee, to Central Alabama.

The Red Mountain is a striking feature in the topography, as well as in the geology of this region. As a conspicuous ridge, rising several hundred feet above the adjacent country, it passes within about a mile of Birmingham and forms the southeast boundary of the valley in which the city is situated.

Some of the most important characteristics of the Clinton ridges have been well stated by those who have had the opportunity of examining them throughout their whole extent within the State.

"In Alabama no more fitting name could be given to it than the *Red Mountain Group*, for outcrops of the rocks of this group are found in ridges, or mountains as they are called, extending almost without interruption from Bibb Co., Ala., to the Georgia line and beyond. From the red ore which seems always to be present in them in greater or less thickness, these ridges have their local name, Red Mountains." * * * *

"In Township 20, Range 6, W., Sec. 15 [near Greenpond Station], the sandstones of the Clinton group are found dipping southeast. These rocks hold three beds of red ore, 7 feet, 4 feet and 3 feet thick respectively, and occupy about 40 feet of strata." [Prof. Smith's Report, 1876.]

"This bed of iron ore extends from a few miles below Pratt's Ferry, on the Cahaba River, in Bibb Co., through Jefferson, St. Clair, Cherokee and De Kalb counties, into Tennessee, a distance of 120 miles." [Prof. Gesner, in McFarlane's Handbook, 1879.]

The Georgia Pacific Railway passes through Red Mountain at Red Gap, six miles northeast of Birmingham, where the ore-bearing rocks and fragments of ore are freely exposed. If they should prove to be productive at this point, mining and transportation will both be inexpensive.

The quantity and quality of the ores of both Quebec and Clinton ages, along the Birmingham Valley, have been fully demonstrated by their extensive and satisfactory use in a number of furnaces. Near Greenpond Station, on the Alabama Great Southern Railroad, about 25 miles southwest of Birmingham, limonite ores have been mined on a large scale for use in the Oxmoor Furnace, where they are employed in admixture with the fossil ores from Red Mountain.

The brown ores for the Alice Furnace are obtained from the same region.

Ores of the same class are mined for the Sloss Furnaces in the valley about eight miles southeast of Birmingham. The Woodward Coal and Iron Co., own a mine in the same neighborhood, from which they expect to supply the large furnace they are erecting at Wheeling, between Birmingham and Jonesboro', in T. 19, R. 4, W.

The Red Mountain ore has been opened on the top of the ridge opposite Birmingham, and about one mile southeast of the city, but from want of knowledge on the part of the miners the good ore was thrown into a heap with that of inferior quality, making a confused mass too poor to be profitably worked. The prolongation of the same bed, farther south, may be seen exposed in the railroad cut at Grace's Gap, on the South & North Railroad, five miles from Birmingham.

The red ores have been extensively mined about two miles northwest of Oxmoor Furnace. The mines are on the crest and southeastern slope of Red Mountain, in a remarkably well defined bed, 7½ feet thick, between strata of hard ferruginous sandstones, which with the ore bed make an aggregate thickness of 30 feet. The ore is sufficiently free from clay to be used without washing. It is carried down to the furnace by rail, and there mixed with one-third of its own weight of brown ore for use in the furnace. This combination yields one ton of pig iron to two tons of the ore, and requires for its reduction one ton of limestone with one and one-half tons of coke.

For the Sloss Furnace, the red ore is obtained from a mine a few miles farther toward the southwest, in T. 19, R. 4 W., Sec. 10. From the out-crop near the crest of the ridge, the bed is worked downward on its southeastern dip, and has a thickness of 14 feet of good ore. It is also approached by a tunnel on the northwestern flank of the ridge, 250 feet below the out-crop. The ore brought out by the tunnel is remarkable for its large percentage of carbonate of lime. Both varieties (No. 1 from the out-crop, and No. 2 from the tunnel) are employed at the same time, mixed with the Quebec limonite in the proportion of one ton each of Nos. 1 and 2, and a half-ton of the limonite. This combination yields one ton of superior pig iron.

The following analyses of the two varieties of ore from the Sloss mine, for which we are indebted to Col. Sloss, will serve to illustrate the composition of the Red Mountain ores generally, and may be regarded as representing two types of ore found at different points along the Clinton formation; the one abounding in carbonate of lime, the other containing very little or none.

Percentage composition.	No. 1.	No. 2.
Ferric Oxide	74.98	58.30
(Corresponding to *metallic iron*	52.48	40.81)
Carbonate of lime	0.00	22.42
Silica (chiefly as sand)	14.56	9.04
Phosphoric Acid (P_2O_5)	1.05	0.57
Equivalent in phosphorus	0.45	0.24

The red ore used at the Alice Furnace is mined in the same ridge as those above mentioned, and about nine miles southwest of Birmingham, near the Alabama Great Southern Railroad. It is worked in the furnace mixed with half its weight of limonite ore, the mixture yielding 52.81% of pig-iron.

The analysis of the red ore of the Alice Furnace mine, kindly furnished by Capt. Hillman, Superintendent, is highly favorable:

Silica	12.18	
Alumina	2.68	
Lime	0.28	
Magnesia	0.39	
Phosphoric Acid	0.29	
Water	2.96	99.70

Metallic iron................56.64.

There are numerous points along the Birmingham Valley, besides those above mentioned, where favorable indications of limonite ores are to be seen accompanying the Quebec limestones and shales. Some of these are found between Birmingham and Jonesboro', as at Mr. Hill's, five miles from the former place, and at the Woodward Company's mine still farther south. Then, beyond Jonesboro', from the neighborhood of Dr. Prince's southward, the same ores occur in abundance.

The Red Mountain, too, still flanking the valley on both sides for a long distance in the same direction, carries with it out-croppings of its characteristic red fossil ores that point to extensive beds beneath. The increasing demand for these ores will soon give rise to new mining enterprises that will bring them into market as a source of wealth to the communities in which they are located, and of patronage to the railroads.

Black-band ore and clay iron-stone have been found at several points in the coal regions, and some samples from the Warrior Field have been tested in the furnaces and found to work well in admixture with the more silicious ores. These are the leading ores in England, and have been very successfully worked in Pennsylvania and in West Virginia, so that their real value has been fully demonstrated. There is good reason, therefore, for making more thorough search for them in all of the Alabama Coal Fields.

The bed of Black-band about, 65 feet below the New Castle coal seam, affords one of the best demonstrations we have of the extent of this ore. It is 1 foot 4 inches thick, and the ore has been tested in the furnace sufficiently to establish its value.

Drift ore is a term sometimes applied to a deposit of impure limonite found in considerable quantities in the stratified Drift heretofore mentioned as spread over the carboniferous rocks in the western part of Walker, and in large portions of Fayette and Lamar counties. The ore is found in greatest abundance cropping out at high points on the faces of the hills as we travel out west of Fayetteville. But its real value remains to be determined by future explorations as to its quantity, and by chemical or furnace tests as to its quality.

"Two miles west of Vernon (Lamar County) are the ore banks which supplied the blast furnace of Messrs. Hall & Murdock. The ore banks resemble those of the Silurian formation in Middle Alabama, and those of the Sub-Carboniferous formation of Franklin and other counties of Alabama. A deep red-colored soil holds masses of ore from the size of a bushel measure down to small pebbles. The ore is in concretionary masses, like the ore of the two formations mentioned. The ore banks are in hills of moderate size, and are found over territory of considerable extent. In one place, where a gully has formed a natural section, the ore is seen to overlie beds of pebbles. The source of the iron in this case is probably the same as that from which is derived the iron disseminated through the sands, etc., of the Drift as coloring matter, viz.: the cherty limestones of the Sub-Carboniferous formation farther north. The nearest point where this limestone is known *in outcrop* is forty miles distant from the ore deposits. It is quite possible, however, that future examinations may show that the limestone exists nearer to the ore hidden by the overlying Drift beds." [Dr. Smith's Report, '77–'78.]

Analyses of three samples of this limonite ore, reported by Prof. McCalley of the State Laboratory, give the following averages of the most important constituents:

Metallic Iron	55.88 %
Silicious matter	4.41 "
Sulphur	0.12 "
Phosphorus	0.22 "

These results compare very favorably with those of analyses of the limonite ores from other parts of the State.

The extent and richness of corresponding ore fields, reported by Prof. Smith, in Franklin County, Alabama, and by Prof. Safford, in Hardin, Wayne and other counties of Tennessee, lead to the inference that future explorations may prove this to be among the most productive and important iron regions of Alabama.

B.—GOLD, SILVER, COPPER, LEAD, &c.

While the chief mineral wealth of Georgia and Central Alabama is treasured up in iron ores, limestones and coals, there are yet other valuable minerals that claim our attention. Of these Georgia holds a liberal share, as will appear in what we have to say about them.

Pyrite and *Chalcopyrite* are names given by mineralogists to the two most important compounds of sulphur with iron and copper. Pyrite, called also *iron pyrites*, is a crystalline mineral of golden yellow color, and, when pure, consists of 47% of iron with 53% of sulphur. Chalcopyrite, known also as *copper pyrites*, is also a crystalline mineral, but of a greenish yellow or light bronze color. Pyrite is so hard as to scratch glass readily, and to strike fire with steel —hence its name; chalcopyrite is much softer, and is easily pulverized.

The chief value of pyrites lies in the sulphur it contains. When heated in a furnace, with free access of air, the sulphur and iron are both burned. The iron is changed into red hematite; while the sulphur is converted into the same gas that arises from the ordinary burning of sulphur, and is passed from the furnace into large leaden chambers, where it is made to combine with steam and additional oxygen and is thus changed into the sulphuric acid so largely employed in the arts—especially in the manufacture of fertilizers.

Chalcopyrite is also valuable as a source of sulphur, but has an additional element of value in the *copper* it contains. Its approximate composition, when pure, is: Sulphur, 35%; Iron, 31%; Copper, 34%. The sulphur is burnt out for making sulphuric acid, and from the residue the copper is extracted in different ways. In the chemical works near Atlanta it is dissolved out by a chemical preparation made for the purpose, which removes the copper and leaves the iron.

This is the most abundant ore of copper; but there are usually several other ores, such as the black sulphide, carbonate, &c., found in the same mines. While chalcopyrite may contain as high as 34% of copper, it is rarely pure enough to yield more than 10 or 12%—generally less. It never crops out on the surface of the ground unless it has recently been denuded by water, or otherwise. The out-crop is usually a bed of porous iron ore, called by the miners "gossan" or "iron hat." This is the iron of the chalcopyrite oxidized, from which both sulphur and copper have been removed. The solid chalcopyrite in the body of the vein is called "mundic ore," a term also applied to a bed of pyrite in place.

The copper belt in Georgia and Alabama possesses some promising features, and has already attracted considerable attention—due in part to the successful utilization of the sulphur of these ores in making sulphuric acid near Atlanta.

Villa Rica, in Carroll County, 38 miles west of Atlanta, is a good starting point for those who wish to make special examination of the present developments and future prospects of the copper ores.

N. P. Pratt, Esq., in a Report of Progress, makes the following summary of observations near Villa Rica, which we give with some abbreviations:

"In 1852–1854 the copper fever spread here from Ducktown, Tenn., causing great excitement over every spot along the lode where hydrated oxide of iron appeared on the surface. High prices were refused by the owners of the lands, many of whom undertook to open mines without any experience or knowledge of mining, and the natural result was loss of capital and final abandonment of the work."

"The construction of the Georgia Pacific Railway, and the Atlanta experiment—which has shown that the sulphur formerly thrown away may be profitably used, and the copper extracted from the residue—have given this matter new life.

"Responsible parties have recently purchased Lots 238 and 239—2d District, 5th Section of Douglas County, and are now engaged in walling up old shafts preparatory to earnest work. Another company has bought the mineral interest in Lots 222 and 223—6th District, 5th Section, Carroll County, &c. In the old 'Wick Shaft,' on one of these lots, work is going on vigorously."

We subsequently visited several of the mines opened in this region. At the Chambers mine, in the borders of Douglas County, work had been temporarily suspended to await the completion of the railway. The ore left on the ground was not rich in copper, but as a source of sulphur it will become profitable under the advantages of improved transportation afforded by the Georgia Pacific Railway.

The Wick mine—now called the Sheppard mine—is near the village, and apparently on the same lode as the Chambers. The "gossan" on the surface is abundant, and we found that a shaft had been sunk through it to the depth of 90 feet, with drifts running northeast and southwest on the lode, which is reported to be from 5 to 6 feet in thickness. The walls are hornblendic gneiss, and the trend is north, 63 degrees east. Samples of the ore are said to have yielded, on analysis, from 10 to 15 per centum of metallic copper. The proprietor was so far encouraged as to have started a second shaft, to reach the vein at another point. This lode, running east southeast, appears to cross the railway about 3 miles west of Villa Rica Station, where good samples of chalcopyrite have been excavated, and where more extended explorations may develop important results.

The Darris mine, a few miles northwest of Douglasville, has ore similar to that of the Tallapoosa mine.

Another, and still broader belt of this ore passes from the northwest part of Paulding into the northeastern part of Haralson County. On this belt the Jones & Hughes mines have been opened, and both pyrite and the chalcopyrite obtained in such quantities as to encourage the proprietors to anticipate profitable mining.

The Tallapoosa mine (Tudor & Hart's), in the northeastern corner of Haralson County, and near the Tallapoosa River, affords the best demonstration we met with of the great results that may be derived from the pyritous ores of this region. This is the mine from which the sulphuric acid factory near Atlanta gets its supply of chalcopyrite.

The strike of the vein is nearly northeast and southwest, its dip

33 degrees southeast, and its thickness from 5 to 6 feet. A shaft has been sunk which strikes the vein at a depth of 42 feet; and an incline has been opened on the vein for 150 feet, with four levels run off on each side along the strike.

The daily output of the mine, when we visited it, was reported to be 20 tons of choice ore selected for shipment, with considerable quantities of leaner ores that will be valuable with the advantages of cheaper transportation. At present the ore is carried on wagons to the railway and shipped to Atlanta. The quantity mined will be greatly increased with increased facilities for transportation. A branch of the Georgia Pacific Railway, a few miles in length, would penetrate this rich mineral region.

Indications of the extension of the copper belt still farther towards the southwest have been found at several points leading into Cleburne County, Alabama. On the southern margin we found the well known Stone Hill (or Wood's) copper mine. Here, work was once carried on quite extensively, but is now suspended for want of cheap transportation. The ore, in former times, after being concentrated by the expulsion of sulphur and removal of a portion of the iron, was hauled to Carrollton, Ga., a distance of 40 miles, to reach railroad transportation. If this heavy item of expense could be obviated, and arrangements made for utilizing the sulphur as well as the copper, there is good reason for believing that this ore could be worked with a large margin of clear profit.

This mine is in Township 17, Range 11 E., Sec. 35, near the southern border of Cleburne County, and about 10 miles from the Georgia line. It was opened in 1874, and several shafts or inclines were sunk to the dark sulphide of copper, which, together with some fragments of carbonates of copper, was the only ore mined for several years. Subsequently, works were erected for reducing the chalcopyrite to such a condensed form as to justify the expensive transportation required to put it in market.

Other mines have been opened on the same belt, both northeast and southwest of the Wood mine, but the owners are generally embarrassed for want of capital and transportation.

If large works for the reduction of the copper metal, and for converting the sulphur into sulphuric acid, were erected at or near the Wood mine, they might afford a market not only for the products of that ore mine, but for all others in the same vicinity; and would justify the construction of a branch railway to intersect the Georgia Pacific Railway at the nearest accessible point.

These pyritous ores of Georgia and Alabama will certainly be made productive, and will become sources of wealth to those who make judicious investment of capital and enterprise for their development.

Lead.—This metal, in the form of *galena*, has been long known to exist in Calhoun County, Ala. The old Draper lead mine is a few miles west of Jacksonville. The ore is found in the dolomitic limestones of Quebec age—the same as those in which are the lead mines of Tennessee and Virginia. The ore here, as in most other localities, is the sulphide of lead, called *galena*, and is accompanied by small quantities of sulphide of zinc, called blende. The occurrence of the Quebec formation (3 b) in all the limestone valleys of Alabama increases the probability of finding lead ore at other points. This ore is readily recognized by its brilliant metallic lustre, its lead-gray color, its weight and its brittleness.

Gold.—From 40 to 45 years ago, a great gold fever spread over a large portion of a belt of country extending from near the Potomac in Virginia, through the Piedmont country east of the Blue Ridge, entirely across North Carolina and Georgia, and into Alabama.

This region is known as the "Great Gold Belt" of the Atlantic Slope. It passes a few miles northwest of Atlanta, and is intersected by the Georgia Pacific Railway near Villa Rica. In some parts of its course it appears to be a single belt of moderate width, while in other places it is made up of two or three subordinate belts, often widely separated from one another.

Around Villa Rica, gold mining was carried on with great activity for ten years—from about 1832 to 1842—during the prevalence of the gold fever in Georgia and Alabama. The most extensive diggings were in the Pine Mountain region, east of Villa Rica, and in the borders of Douglas County, where explorations were extended over several hundred acres. Then, on the west and northwest of the town, other areas of wide extent were worked over in the rough way generally prevalent at that period in all the gold diggings. The mining was confined chiefly to "placer deposits"—localities where gold is found mingled with the debris of the country rocks. Wherever water could be conducted near the mines, it was led through trenches provided with sloping bottoms, and into these trenches the gold-bearing clay, sand and pebbles were thrown to be washed by the running stream. This mass of material was then stirred, when the transporting power of the water—aided by the use of shovels and hoes—carried the portions lighter than the gold some distance down stream. Meanwhile, the particles of metal settled down, by reason of their greater specific gravity, into little cavities along the bottom of the trench, and were scooped up and thrown into pans, together with considerable quantities of sand and small pebbles —from which they were next separated by the skillful use of water, aided by the hand. Particles of the metal large enough to be handled were picked out, and the smaller portions were collected by combining them with mercury—amalgamation. Water is essential to this system of mining, and hence it was limited to the margins of the streams, which in this region are small.

We were informed that in 1840 not less than 800 or 1000 men were engaged in mining around Villa Rica, and large quantities of gold were sent to the U. S. Mint; far less, however, than would have been obtained with an adequate supply of water. Since then the business of mining has dwindled away, and at the time of our last visit we found only a single individual (Mr. M. N. Webster) engaged in it. This gentleman was fitting up a little stamping mill, to be worked by steam, at the old Clopton mine near the village. He had recently uncovered a vein of gold-bearing quartz, with several minor veins apparently branching off from it, and the quartz was rich enough to encourage him to prosecute his work. The embedding rocks are mica schists and shales, that decay rapidly under the weather and are not difficult to excavate in mining.

Three tolerably distinct lodes of auriferous quartz have been opened, occupying a belt a quarter of a mile or more in width; but all have been abandoned except the one mentioned above. The scarcity and uncertainty of the supply of water, especially in summer, is said to have been the chief cause of giving up the work. The total width of the gold belt, here, cannot be less than a mile, and it must pass through the ridge on which the town stands.

The contiguity of this part of the gold field to the Georgia Pacific Railway, and the strong probability—certainty, we might say—that it can be re-opened and worked with profit by the use of the present improved appliances for mining and reducing the ores, make it worthy of consideration on the part of enterprising capitalists. The copper belt heretofore mentioned lies but a short distance northwest of this point.

Another striking demonstration of the richness of this gold belt is found in the old Owen (or Holland) mine in Haralson Co., about eight or nine miles southwest of Buchanan, and about five miles from the line of the railway. The lode has been quite extensively worked, and the mining is said to have been profitable when skilfully managed. The lode, as exposed, consists of three veins of dark, grayish-brown, porous quartz—carrying gold, both free and in pyrite. The veins run with the embedding mica schists and slates, that here have a strike nearly east and west, with a dip south of about 35 degrees.

Work was suspended at the time of our visit; but the most recent operations with the present machinery were reported to have mined and reduced an average of ten tons of ore per day, which yielded from $2.50 to $3.00 per ton. Capital and enterprise could certainly improve the machinery, enlarge the operation greatly, and under good management increase very largely whatever of profit may have been hitherto realized.

In Alabama, the extension of the gold belt occupies portions of Cleburne, Randolph, Clay and Talladega counties. The point which affords the best illustration of the character of this portion of the mining region is Arbacoochee, Cleburne County, once very famous for the extent and richness of its mines.

"The whole face of the country about the old town of Arbacoochee has been dug over, the greater part of the work having been done soon after the first great excitement, about 1836." [Dr. Smith's Report, 1874.]

A considerable portion of the village stands on an old "placer" mine. We visited an old mine, west of the village, that is worked on a very limited scale by Rev. L. B. Denson. He works altogether in a placer deposit, and by the primitive washing and panning process. Numerous openings have been made here on a ridge running nearly east and west, with several spurs (the results of erosion) extending out at right angles from its base. On this ridge and its spurs is an extensive placer deposit, resting on decaying schists and slates and covering many acres of surface. The deposit is composed of pebbles of quartz mingled with micaceous clay and sand, and is sometimes 10 feet thick. It thins out on the slopes and spurs, however, until on some exposed places auriferous quartz veins are seen dipping towards the southeast—all enclosed in the same country rocks that carry the gold veins at nearly all other localities along this portion of the belt.

Two miles east of the town of Arbacoochee, we examined the Houston & Pinson mine, formerly known as the Chilton & Trammell mine. The tract of land attached to this mine covers 960 acres, of which 70 acres are cleared; the remainder bears good timber. Mining has been carried on here ever since 1840, chiefly on the placer system, but several auriferous veins have also been exposed. Mr. Houston, one of the present proprietors, claims that three of these veins, nearly parallel with one another, run entirely through the property. Two of them are very close together, but differ somewhat in thickness. The third is some distance from the others.

A stamping mill with pumps and washers, operated by steam, was worked for some time very successfully. Operations were suspended recently on account of some disagreement between the proprietors. Mining on the veins has been extended to depths of 30 to 50 feet, when the accumulation of water, the inadequacy of the pumping machinery, and perhaps, too, the more pyritous character of the veins, have caused the openings to be abandoned. The hanging wall of the two contiguous veins, or double vein, is a hard talcose (hydromica?) slate; the foot wall is of softer and micaceous slate. The old Crutchfield mine is on Houston & Pinson's tract.

Mining in the placer diggings and in the veins near the town is said by the citizens to have yielded some considerable fortunes in past times. At Mr. Denson's we saw evidence of gold in considerable quantities, in both the placer debris and the veins in place.

The Arbacoochee region is certainly one of the most inviting fields for those who wish to invest capital and enterprise in the fascinating business of mining for gold.

The Chulafinnee mines of Cleburne County, southwest of Arbacoochee, and three miles west of the village of Chulafinnee, were worked for a long time by the old panning process; but more recently a stamp mill has been operated with water power, with varying success.

The Pinetucky gold mine is south of Arbacoochee, and in the northern part of Randolph County. "The first gold was found at this place in 1845. * * * * The gold is found in a thin layer of quartz, interstratified with the garnet-bearing mica schist. The present proprietor of the mines, Ex-Governor W. H. Smith, has sunk two shafts to the depth of sixty feet upon this quartz seam. The mill of ten stamps is driven by steam power, by which also the mine is drained, and the water furnished for ore-washing. * * * * Governor Smith gives as an average yield of gold for the quartz mined here, $11 to $17 per ton." [Prof. Smith's Report, 1874.]

We have given enough cases of both the older and the more recent operations in that portion of the great gold belt of the Archæan area southeast of the Blue Ridge Range, and intersected by the line of the Georgia Pacific Railway in Georgia and Alabama, to illustrate what has been done here in the past, and to indicate what the proper appliances in the way of machinery and skill may accomplish hereafter in the production of gold.

Manganese.—This metal is never used in the metallic state, except in the case of its alloy with iron, called Spiegeleisen, employed in the manufacture of Bessemer steel; but its ore, called di-oxide or per-oxide of manganese, is consumed on an immense scale for liberating chlorine from hydrochloric acid, and from common salt, for the manufacture of bleaching powder (chloride of lime).

Chlorine, prepared in the same way, is also the agent by which bromine is liberated from its compounds as they exist in the mother liquors of many salt-works.

Manganese per-oxide, when very free of iron oxides, is utilized in the manufacture of glass. It has the property of neutralizing the brown and green tints given to glass by the iron which often occurs in the sand of which the glass is made; hence it has been called "Pyrolusite," glass-maker's soap.

The constantly growing demand for good manganese ores—chiefly the di-oxide—has greatly stimulated the search for this mineral within the last few years.

Wherever this ore is found, it bears marks of having been precipitated from solution in water, Hence, like the ores of iron similarly precipitated, it is found to some extent in geological formations of all ages. But in the belts of country lying along the two flanks of the Blue Ridge range—the Archæan belt along the southeast, and the Lower Silurian belt along the northwest—we find nearly all of the manganese mines that have been profitably worked southeast of the great Appalachian Coal Field.

In Virginia, several manganese mines are successfully worked, east of the Blue Ridge, in the Huronian division of the Archæan rocks; and, west of the Blue Ridge, in the shales of the Potsdam division of the Lower Silurian or Cambrian Period.

The manganese ore found along the western base of Ladiga Mountain, and employed at one time in the manufacture of Spiegeleisen, has been mentioned in connection with the iron ores of the same neighborhood. The construction of a furnace especially adapted to the preparation of the alloy of iron and manganese, would probably lead to the consumption of large quantities of this mineral when it contains too much oxide of iron to render it suitable for other purposes.

Manganese is readily distinguished from ores of iron by its bluish-black color in solid mass, and still darker color when reduced to fine powder.

Its specific gravity is greater than that of brown hematite and about equal to that of magnetic iron ore. When heated red-hot it loses a part of its oxygen and becomes reddish brown in color.

Barytes, or Sulphate of Barium, is a soft white mineral, having the general appearance of some forms of gypsum or limestone, but much heavier than either of these minerals. The pure varieties are valued for use in the preparation of white paint. *Venice White and Hamburg White* lead, are mixtures of baryte with white lead. It not only adds to the opacity of the white lead, but aids in protecting it against the tarnishing effects of sulphur gases.

It frequently constitutes the "gangue" accompanying the ores of lead and some other metals; and is still more largely associated with ledges of limestone, but in distinct beds. One of these beds is associated with Silurian limestones near Elyton, a short distance southeast of Birmingham. It has also been met with at several points along the narrow limestone valley which separates the Coosa and Cahaba coal fields; but explorations have not been made by which its extent and quality can be well determined.

The most promising bed of baryte we saw is in the valley of the Little Cahaba, about 3 miles south of the point at which the railway crosses that stream in going to Birmingham. It is on the land of Mr. H. Little, in T. 17, R. 1 E., S. 31. The bed, as far as exposed, is 3 to 4 feet thick, and imbedded between strata of Lower Silurian limestones, having a steep southeastern dip. The outcrop has been traced for a quarter of a mile, but its limits have not been ascertained. Large portions of the mineral are white, and bluish white, producing a very clear white powder. Other portions are considerably stained with oxide of iron, but could be readily bleached with dilute sulphuric acid, in which the mineral is insoluble while the coloring oxide of iron is soluble. The finest white paint of this kind is prepared by roasting the crude baryte with charcoal in covered crucibles, dissolving in hydro-chloric acid, and then adding sulphuric acid, which throws down barium sulphate as a beautiful white powder—employed for some of the finer kinds of white painting.

If the bed of baryte above mentioned, on being fairly opened, turns out to be of the extent indicated by its outcrop, it will yield many thousands of tons of the mineral.

Graphite was found in the Archæan rocks of Cobb Co., about two miles north of the line of the railway, near Ross' store. There are indications of several seams running parallel with one another. The widest exposure was about two feet. From this deposit, N. P. Pratt, Esq., obtained about 50 pounds for the Atlanta Exposition. He also sent a sample to New York, which was valued at $20 per ton. The graphite here is imbedded in hydromica slate. The outcrop is on a hill-side where mining would be easy.

Another bed of graphite was cut in sinking a well in Haralson Co., Lot 105, Dist. 20, Sec. 3, but its extent has not been determined. The mineral occurs also in Carroll Co., Ga., and in Cleburne, Clay and Randolph counties, Alabama.

CORUNDUM is a mineral very much sought for on account of its several important uses. It is a crystallized form of alumina, found only among metamorphic rocks or their debris. In its purest and most perfectly crystalline form it stands next to the diamond in hardness. When of a clear blue color, it is the true *sapphire;* when of a bright red color, it is oriental *ruby;* when clear yellow, the oriental *topaz;* when green, the oriental *emerald.* The highest grades of sapphire and ruby are very rare, and vie with the diamond in value. There is reason to believe, however, that deeper mining will bring to light some valuable specimens.

But the most extensive use to which this mineral is applied is due to its excessive hardness, in which respect it ranks next to the diamond.

The crude and dull-looking crystals are called *corundum;* the dark, granular and less pure varieties are called *emery.* Both of these varieties are crushed to powder, of different grades of fineness, and employed as abrading and polishing material. The powder of crushed corundum crystals, however, is more highly valued than that of the less pure emery.

Mr. Pratt gave special attention to this mineral, and collected some valuable facts in regard to it. He says: "The first locality is about two miles south of Powder Springs, in Cobb Co., Ga. * * * Here, about 160 pounds was taken from the surface; one piece, of a flesh color, weighing as much as three pounds. * * * The average quality of the mineral is much finer than any I have seen in this country, not excepting the best specimens from North Carolina. The prevailing color is a dark flesh red, and the mineral almost free from impurities. Besides the large masses, characteristic crystals of a grayish color and rough surface were also found."

" A second locality of corundum is near Villa Rica, in Carroll Co., Ga. From this point as much as a wagon load has been removed from the surface by different parties. * * * * Specimens, of various sizes, were scattered in a line running southwest through two 40-acre lots."

" The only locality as yet known in Alabama extends from Dudleyville, Tallapoosa Co., ten or fifteen miles southwest. Fragments of corundum are found at intervals for this distance, yet the position of the beds or veins is made out in only one or two instances." [Prof. Smith.]

Asbestos is a fibrous mineral, occasionally as flexible and tough as carded flax; but the fibre of the greater part of it is more rigid. Some of the compact varieties resemble petrified wood. The composition of the light colored varieties is, essentially, a double silicate of magnesia and lime; it is very infusible and a good non-conductor of heat. The fine fibrous variety has been sometimes made into cloth for fire-proof cloaks, hats, &c. To facilitate the spinning and weaving, it is sometimes mixed with cotton, which is afterwards burned out. The more brittle varieties are employed as packing for fire safes and steam boilers, and in the manufacture of paint for fire-proof roofing.

The finer qualities of this mineral have not been found, as yet, in any considerable quantities in this region. But at a number of points in Fulton, Cobb, Douglas and Carroll counties it is found of a character suitable for fire-proof roofing, packing, &c. It occurs in seams from a few inches to two or three feet thick.

We have seen some fair specimens from both Cleburne and Randolph counties, Ala. Prof. Smith mentions it as also occurring, in connection with corundum, in Tallapoosa County.

Indications, especially in Georgia, are quite sufficient to attract the attention of those who wish to make investments in utilizing this peculiar mineral.

Mica.—This mineral, under several varieties, occurs in thin scales and folia, more or less transparent. Its scales abound in granite, gneiss, mica schists and other metamorphic rocks, and when these decay the resulting mass of clay has the scales of mica disseminated through it. Scales of mica are also abundant in nearly all the sandstones and conglomerates above the Millstone Grit in the

Coal measures, and also in beds of Mesozoic rocks, south and west of the Alabama Coal Field.

The chief value of mica arises from its toughness, transparency and resistance to heat—qualities which make it valuable as a substitute for glass in lanterns and in the windows of stoves. The *Muscovite* variety is the only one found in folia sufficiently large and transparent for ordinary use. It occurs in masses of foliated structure, which are easily split into sheets of any desired thickness. Its essential constituents are silica, alumina and potassa, often colored with iron.

Very little attention has heretofore been given to this mineral in either Georgia or Alabama. Promising samples, however, have been obtained from near McAfee's Ferry, in Fulton Co., from several points in Paulding Co., and from near Carrollton, Carroll Co., Georgia. In Cleburne Co., Alabama, between Arbacoochee and Wood's copper mine, some developments have been made that promise successful results. "From Randolph Co., southeast to Chilton, along a belt of mica schists, occur many old excavations in beds or veins of coarse-grained granite (gneiss?). The numerous large plates of mica about such mines have often attracted attention, and in many instances there are traces of subsequent work." [Prof. Smith.] *Biotite* is a black or dark green mica—a frequent constituent of dark granite, and sometimes mistaken for hornblende.

Talc—Soapstone—(Steatite).—The term *talc* is usually limited to the crystalline, foliated variety of a silicate of magnesia, while *soapstone* or *steatite* is applied to the massive variety of the same mineral. The foliated kind has usually some shade of green, but is sometimes white or light gray. It feels greasy, and is so soft as to be easily impressed with the finger-nail. The compact form (soapstone) is generally gray, or greenish gray, and is so soft when freshly quarried as to be easily cut, sawed or turned to any desired shape, but hardens greatly on exposure.

It stands heat so well as to be largely employed in place of fire-brick for lining furnaces, stoves and fireplaces. The finer qualities are sometimes used, in admixture with kaolin, as an ingredient in the manufacture of porcelain. An impure variety called "pot-stone" (*lapis ollaris*) has been employed as the material out of which cooking utensils were carved. Many pots, dishes and vessels of different shapes are found among the "Indian relics" of this country. The best specimens of soapstone that we saw were from Douglas, Fulton and Paulding counties, Georgia. It has been quarried successfully about five miles south of Douglasville.

Among the metamorphic rocks of Cleburne and adjoining counties of Alabama, beds of soapstone are found; and along the bed of rocks extending from Cleburne towards the southwest, many excavations are reported, from which the aborigines are believed to have mined this mineral for making their domestic implements.

Fire-clay is a somewhat silicious white clay, containing but little iron or lime, and hence very infusible. The first quality of it is greatly in demand for the manufacture of fire-proof bricks for lining furnaces of various kinds, and for terra-cotta work. Fire-clay is not limited to rocks of any particular geological age. It is most abundant among the Archæan rocks, because it is often the direct result of the decay of feldspar or very feldspathic granites. But we find beds of it immediately beneath beds of coal, and even among rocks of much more recent date.

The following case occurs among the Lower Silurian rocks, and indicates that similar beds may be found at other points in the Birmingham Valley: "At Bibbville, a manufactory of fire-brick was an object of interest. The material of the brick is obtained from large pits close to the Station. It consists, 1st, of a tolerably white and plastic clay; and, 2d, of a moderately coarse-grained, arenaceous deposit, made up of grains of quartz sand held together by a cherty cement. The baked brick, when examined with the lens, resemble to some extent specimens of Millstone Grit, the quartz grains being a prominent ingredient. These bricks are much used in the construction of the furnaces and rolling mills, and are highly recommended by those using them." [Smith's Report, 1876.]

The white clays found at many points along the line of the Georgia Pacific Railway, between Atlanta and Birmingham, will make good fire-bricks—especially when mixed with white silicious sand or crushed quartz rock. The presence of fine scales of light colored mica is regarded as advantageous, as they give strength to the bricks. The main points in selecting material are to get: 1st, a moderately plastic clay, free of iron, as will be indicated, generally, by its white color; and, 2d, a bright-colored silicious sand in moderately fine particles.

The upper beds of the Millstone Grit of the coal regions have already been mentioned as affording a fire-proof stone of superior quality for furnace hearths. It has been fairly tried at the Oxmoor and Birmingham furnaces, and the Georgia Pacific Railway will bring it within easy reach of many other like establishments.

BUILDING MATERIAL.

G. J. S. C.

Brick clay is found without limit in all the clay hills and alluvial bottoms along this railway. On the banks of the Chattahoochee River, eight miles west of Atlanta, extensive kilns are kept in constant operation in order to meet the increasing demands of the Atlanta market.

Granite, in great abundance and of easy access, occurs along the line, within 20 to 35 miles of Atlanta. Before reaching Douglasville the road cuts a bed of gneissoid granite, where an extensive quarry could be readily opened in a rock of beautiful appearance and of superior quality. At several points around Douglasville quarries have been partially opened, and good samples of the granite may be seen in the village.

Between Douglasville and Villa Rica, and at points in Carroll Co., still farther west, these granite beds form the frame work of a number of low hills, and crop out along the banks of small streams, where quarries could be opened at comparatively little cost.

Limestone suitable for building purposes, and for making lime, abounds at numerous places between Davisville Tunnel and a point some miles west of the Coosa River. The same limestones make their appearance, again, in the little Cahaba and Birmingham valleys, which separate the several coal fields. Along the western margins of both the Coosa and Cahaba coal fields extensive outcrops of the Sub-Carboniferous limestones are also within reach of the railway.

Marble is nothing more than a fine quality of limestone, and is found of various grades and shades of color in all limestone regions. The finest marbles, as well as the most durable, are generally found among metamorphic rocks—they are in fact metamorphosed limestones. We found a bed of this metamorphic marble on a little branch of Beech Creek, about four miles west of Buchanan, on the land of Mr. Driver. The stone is very compact, has a fine granular crystalline structure, is of bluish white color, and would evidently take a fine polish.

Roofing slate has been quarried largely at the base of Dug-down Mountain, in the southern part of Polk Co., Ga. The same belt of metamorphic slate extends towards the southwest into Cleburne Co., Ala., and approaches, if it does not cross, the line of the Georgia Pacific Railway. But no developments have yet been made so far south,

Flagging stone, nearly akin to slate, has been quarried on Lot 705, District 20, Section 3, Haralson Co., Ga. This slaty rock is easily quarried, and can be split into slate of any desired thickness and of large size. It is of excellent quality for either curbing or paving stone.

C.—IRON MINING, MANUFACTURING, &c.

The vast and varied mineral resources which we have represented as most conspicuous features of the belt of country traversed by the Georgia Pacific Railway, although far from being fully developed, are not lying entirely hidden as treasures to be utilized at some future day. Industrial establishments are already making them sources of large profit to their owners, of wealth to the communities in which they are located, and of patronage to the railroads that come within their reach.

Mining and manufacturing industries and railroad enterprises must move forward hand in hand. Heretofore, the region from Atlanta, Ga., to Oxford, Ala., has had no railway facilities; it now has the Georgia Pacific, and is already becoming the scene of active work.

The Chemical Works near Atlanta are already consuming the iron and copper pyrites abounding along this line, in the manufacture of sulphuric acid and chemical fertilizers. The chief fertilizing material manufactured here is super-phosphate of lime, which is prepared by grinding the mineral phosphates of South Carolina, while moistened with the sulphuric acid made at the mill.

Thus, while important materials are carried in one direction to reach the factory, the products, in the form of fertilizers, will be carried back to reach the farmers at every station along the line of railway.

Atlanta is destined to be one of the great consumers of material to be brought from the coal and iron fields of Alabama; but of this we shall say more in another connection.

The Woodstock Iron Works at Anniston are utilizing, on a large scale, the mineral resources of which we have been speaking. The following letter indicates the amount of tonnage and travel to be derived from this establishment, as well as from the Alabama Furnace, a few miles farther south, but under the same general management:

OFFICE OF WOODSTOCK IRON CO.,
ANNISTON, ALA., June 27th, 1882.

R. H. TEMPLE, *Chief Eng.*, Atlanta, Ga.:

Dear Sir,—Yours of 24th received. I herewith enclose you statement of the business of this Station. The year ending April, 1882, would show a large increase over 1881. With your road open to Atlanta, the Eastern market would, we think, be the best market for our pig iron. We have not shipped as much to the New England and Middle States as formerly, as we have not been able to supply that market on account of freight and transfers.

Our ore and timber lands lie west of Anniston and on the line of your Road. We use 150 tons of ore, and eight to ten cars of charcoal per day. Your Road will give us our best connection with the East, and with our Western market. As to what will be needed here in future, that will depend on your Road. We cannot increase our charcoal furnace capacity; but, with the Georgia Pacific reaching the coal and fossiliferous ore in St. Clair, this point would be as favorable as Birmingham for coke furnaces. Our policy will be, at the proper time, to put up such furnaces.

The Wheel Works, and Steam Forge, of Noble Bros. & Co., will require from eight to ten cars of freight per day. * * * *

It will require a branch of only four miles to connect Alabama Furnace with your Road. We may build this, and a road from Alabama Furnace to the Clifton ore banks. In this case you would get the bulk of the business of the Alabama Furnace, and connect this furnace with the Clifton ore mines. The Clifton ores we wish to use to a considerable extent at the Furnace here. The Clifton banks are very extensive.

Very respectfully,

(Signed) SAMUEL NOBLE,
Secretary and Treasurer.

STATEMENT SHOWING FREIGHT BUSINESS AT ANNISTON, ALA.

YEAR ENDING.	FORWARDED.	RECEIVED.	TICKET SALES.	TOTAL.
March 31st, 1874.........	$6,918 99	$8,014 21	$872 15	$15,805 35
" 1875.........	10,560 62	4,580 66	995 80	16,137 08
" 1876.........	9,924 56	3,084 61	1,056 90	14,066 07
" 1877.........	13,470 81	2,701 50	894 00	17,066 31
" 1878.........	12,715 48	3,754 02	961 50	17,481 00
" 1879.........	14,145 39	4,676 36	1,315 95	20,037 70
" 1880.........	19,857 08	11,336 81	1,988 80	33,182 69
" 1881.........	28,888 39	20,172 90	2,464 20	51,525 49
Totals..............	$116,481 32	$58,321 07	$10,549 30	$185,351 69

(Signed) **RAY KNIGHT,**
A. G. F. & P. Agt.

As an additional illustration of the extent to which the mineral resources along this line are already utilized, we shall give a brief summary of the leading operations at Birmingham. Twelve years ago the site of this flourishing little city was an old cotton plantation. Now it claims a population of 12,000, and is rapidly growing. As to its future there can be but one opinion. It is destined to be the centre of iron industries in Alabama—in fact, such is its position already.

Situated as the city is, in one of the most productive iron ore and limestone regions of the South, between two coal fields soon to be penetrated by the Georgia Pacific Railway, and from which extensive supplies of timber will also be drawn, its material resources may be regarded as practically inexhaustible.

Two large blast furnaces, consuming coke, are already in active operation; two more will soon be at work; and a fifth, intended for the manufacture of charcoal iron, will be completed at an early day.

A large rolling-mill and four foundries are also in operation, and many industrial establishments of a less conspicuous character are rapidly springing up.

The material consumed by these several establishments, and the resulting products, will still more forcibly illustrate the point we have in view:

Material consumed MONTHLY *by the two Alice Furnaces.*

Ore in two furnaces	9,000	tons.
Coal “ “	10,000	“
Limestone in two furnaces	4,500	“
Products in pig iron	4,500	“
Total material and products	28,000	“

Material and Products of Sloss Furnace.

Ore consumed *monthly* in two furnaces	9,600	tons.
Coal “ “ “ “	10,800	“
Limestone “ “ “ “	4,500	“
Products in pig iron	4,800	“
Total material and products	29,700	“

Material and Products of Charcoal Furnace. (?)

Ore *monthly* (probably)	2,000	tons.
Charcoal “	2,500	“
Limestone “	1,000	“
Products in pig iron, estimated	1,000	“
Total	6,500	“

Material and Products of Rolling Mill and Foundries.

Coal consumed monthly	2,500	tons.
Products estimated	2,500	“
Total	5,000	“

Thus, we have an aggregate tonnage of material and products to be handled by the several railroads passing here, amounting to 69,200 tons per month in the iron business alone. Other lines of business will advance, of course, as the iron business becomes more fully established and more widely varied in its operations.

The demand for railway transportation will increase rapidly with the growth of business in the manufacturing towns and cities. And the more direct the line of communication between them, the greater will become the interchange of both tonnage and travel.

The Georgia Pacific Railway will have the advantage of being not only the most direct line of communication between the industrial establishments at these points, but, also, that by which they must get the greater portion of the materials they consume; and will, moreover, be one of their best routes for reaching, either directly or indirectly, all the leading markets of the Mississippi Valley on the one hand, and of the Atlantic Slope on the other.

D.—COAL.—THE ALABAMA COAL FIELD.

The Georgia Pacific Railway runs, for about 100 miles, across the richest part of the Alabama Coal Field. The shape and location of the field are shown on the accompanying map. It has an estimated area of 5,400 square miles, and is the southern terminus of the Appalachian Coal Field. With the exception of its northern margin, the whole field belongs to one hydrographical basin. The drainage is through the Coosa, Cahaba, Black Warrior and Tombigbee rivers, which are united before reaching Mobile Bay. The extremes of elevation are 250 and 800 feet. The ridges and plateaux are usually 500 to 600 feet above sea level. The region is without swamps, healthy, and free from extremes of temperature. It is composed of level, smooth and often wide-topped ridges, with wide terraces, and with narrow, steep-sided valleys, running in all directions, from 100 to 400 feet below the crest lines of the ridges. As more fully stated elsewhere, the country is largely in timber, but all the smooth valleys, and many of the coves and plateaux, are cultivated.

The Alabama coal region is no exception to the general statement that the east—or, more strictly, the southeast—margin of the Appalachian Coal Field is folded and fractured, whilst the westerly extension is more regular. These disturbances have broken the Alabama field into three unequal parts, the two eastern being quite small in comparison with the western, and each being named from the river which drains it, to wit, the Coosa, Cahaba, and Warrior. The coal area of the Coosa Field is estimated by the State Geologist, Prof. Eugene A. Smith, at 150 square miles; that of the Cahaba Field at 250; and that of the Warrior Field at 5,000. The Carboniferous rocks of the Coosa Field extend northeast and southwest from Calera to Eastport, a distance of over sixty miles, the width of the belt varying from 5 to 12 miles.

The Cahaba Field seems to be a prolongation of the axis of Lookout Mountain, but is cut off by a gap at Ashville, which leaves it about the length of the Coosa Field. Its width at the north end is not so great as that of the Coosa Field, but it widens more toward the south. The Warrior Field is pear-shaped, the heavy end being to the southwest, and is nearly 60 miles wide on the line of the Georgia Pacific Railway.

In structure, the Coosa Field is a pair of skiff-shaped troughs, joined at their northern extremities and gradually widening southward. The Cahaba Field has the general shape of the Coosa, and has one or more folds near the middle, running lengthwise through the field, but not broken through to the underlying strata as in the case of the Coosa Field.

The structure of the Warrior Field demands more attention; but we will give here only its main features, leaving certain irregularities to be considered in a special connection. The marginal rocks for 75 miles on the east edge of the Warrior Field are in some places inclined away from the Birmingham anti-clinal valley, with a northwest dip; at other places are standing vertically; and at others, again, are tilted back until the dip is southeast, and the order of the strata reversed. But within a mile of the margin, usually, the strata settle to a gentle northwest dip, and undulate westward. Between the Locust and Mulberry prongs of the Black Warrior River there is clearly exhibited the declining crest of the great Sequatchie anticline, which comes down from Tennessee and dies out in the fork of the river, dividing the Warrior Field into two geologic basins. The east basin lies between the margin described awhile ago—whose upturned edge is known as Sand Mountain—on the one side, and the anti-clinal between the rivers, here known as Democrat Ridge, on the other. The west basin extends from Democrat Ridge to a crest which, though not clearly defined, runs southward on a line east of, and nearly parallel with, Lost Creek West of this crest the strata are nearly horizonal. The lowest lines of depression in the two basins are about 200 feet below their margins. These basins do not correspond with the surface undulations; the valleys and ridges run in all directions, and, in the East Warrior basin, without reference to the geological syncline.

The dividing axis of elevation between the basins north of Democrat rises into a high ridge (known as Reid's Mountain) which, however, is truncated and grooved into a valley from near Blount Springs northward. From a point a short space above Democrat, southward, the crest is also channeled, though not deeply; four miles south of Democrat it is scalped to a flat surface for a few miles, beyond which it rises once more into a double crested ridge, 300 feet above the rivers; and it is finally broken across, though possibly not extinguished, by the closing rivers.

The drainage valleys in the West Warrior Field bear a somewhat marked relation to the rock strata, and particularly to the coal seams and their accompanying shales. The channels of the Mulberry Warrior River, and of some of its largest tributaries, have been determined by the dip of the rocks and the friability of some of the larger coal beds and their accompanying shales. For, be it noted that the strata are influenced not only by the two local synclines, but also by the gradual depression to the southwest of the whole terrane, until it is lost from sight beneath the Cretaceous and Quaternary sands, clays and gravels.

Before considering the contents of the three coal fields proper, we will look at the Sub-Carboniferous rocks, which, in Tennessee, Virginia and elsewhere, contain coal beds of economic importance, and which in Alabama are known to contain coal, though as yet no workable beds have been discovered.

THE SUB-CARBONIFEROUS GROUP.

The Carboniferous rocks of Alabama, considered as a whole, are naturally divided into two groups by the Sand Mountain Conglomerate, which is a bed of sandstone, usually about 100 feet in thickness, whose edge shows itself prominently in mural lines on one or both sides of the narrow limestone valleys that divide the coal fields. This rock is admitted by all geologists who have examined it to be the bottom member of the Great Conglomerate, or Millstone Grit, unfortunately called by the early geologists "the floor of the coal measures." Beneath this rock we find the Lower, or so-called Sub-Carboniferous group, which here varies from 300 feet to twice, or perhaps thrice, that thickness. Assuming the correctness of the opinion expressed by Professors Tuomey and Smith, of Alabama, and Professor Safford, of Tennessee, that a certain stratum of dark shale, about 20 feet in thickness, which is usually found underlying this group, belongs to the Devonian Age, we would offer the following as a provisional section of the Sub-Carboniferous rocks as shown on, or near, our line of exploration. Time did not allow of detailed study and exact measurements. The descriptions we give of the shales, sandstones and upper limestone which constitute the upper half of the group, apply best to the western margin of the Cahaba Field, in the valley of Shades Creek, though we think them also applicable, substantially, to the Coosa Field. They might answer also, in a general way, for the eastern edge of the Warrior Field, on Cunningham's Creek, ten miles north of Birmingham; but southwest of that creek the upper shales and soft sandstones, and to some extent the upper limestones, have been ground out and squeezed out by the contortions of the hard quartz beds between which they once lay, as between the upper and nether millstones.

PROVISIONAL SECTION OF THE SUB-CARBONIFEROUS ROCKS.

Descending geologically from the Sand Mountain Conglomerate:

5. Alternating shales and sandstones, generally soft; yellow the prevailing color, but sometimes greenish, or orange red. Thin seams of coal near the top. Total thickness, say 500 feet.

4. Light blue limestone, very pure, with bands of shales and chert. Black shale at top and bottom, sometimes apparently substituted altogether by shales and chert. Total, 75 to 150 feet.

3. Beautiful white, or cream colored, sandstone; sometimes hard and flinty; usually fine grained to gritty. 20 to 50 feet.

2. Blue, silicious limestone, enclosing blocks and layers of ferruginous, crinoidal chert, and weathering into a deep-red soil containing iron ore. 20 to 150 feet.

1. Whitish sandstones, sometimes impure and cherty; hard or soft; sometimes conglomerate; sometimes with alternating beds of shale, and a little iron ore. 20 to 100 feet.

Remarks.—No. 1. At Boyle's Gap, 5 miles north of Birmingham, where Five Mile Creek passes through Sand Mountain, No. 1 is a hard white sandstone containing small pebbles. It is seen at the west end of the railroad bridge, and also in the gap below, where it is about 20 feet thick and lies against the Clinton sandstone, without the intervention of the Devonian shales. In Grace's Gap, southeast of Birmingham, where the South & North Alabama Railroad passes through Red Mountain, No. 1 consists of thin beds of chert lying on the Clinton sandstone; 40 feet exposed. In Red Gap, 6 miles northeast of Birmingham, where the Alabama Great Southern Railroad and the Georgia Pacific Railway pass through Red Mountain, No. 1 overlies dark shale, and consists of at least 100 feet of soft, light colored sandstones, with beds of purple and variegated shale, and thin bands of chert and iron ore. Near Woodward's coal shaft, ten miles southwest of Birmingham, it is a hard, dirty yellow, calcareo-silicious conglomerate, with a rough dark-blue surface.

No. 2 is in some members so silicious as to be scarcely distinguishable from No. 1, but there seems to be in it, always, a stratum of blue limestone containing nodules of chert, and readily decomposing into a deep-red soil that contrasts strongly with the soils below and above. This is the chief iron-bearing stratum of the Sub-Carboniferous group. The liberal deposits of iron ore on Oak Ridge, in Cahaba Valley, and on Daughdrille's Mountain, in the Coosa Coal Field, belong to No. 2.

No. 3 is quarried at Grace's Gap, and also in the valley of Shades Creek, near Red Gap, where it is 20 feet thick, and forms the low ridge through which the Trussville wagon road passes at Albert Herron's, 8 miles from Birmingham and a quarter of a mile west of Red Mountain. It is also visible at Boyle's Gap, and at several gaps on the east margin of the Coosa Coal Field, where the strata are reversed. A most remarkable display of No. 3 may be seen in a secluded valley, between Sand Mountain and West Red Mountain, east of Newcastle. Here it forms a hard sandstone wall—perhaps 50 feet thick, and from 25 to 100 feet high—standing naked, vertical and for the most part detached, in the midst of the valley, which it divides into two equal portions. This remarkable rock is equi-distant (about a quarter of a mile) from the crests of the mountains on each side, and is said to be continued for miles. Its local name is Rocky Row.

No. 4, which is distinctively called the Mountain Limestone by the local geologists, is used as a furnace flux, and is largely quarried at Trussville. The black shale of No. 4 has been thrown from wells on the east margin of the Coosa Field, and from a well at Albert Herron's. It may also be seen, somewhat lighter in color, at Boyle's Gap.

The shales and sandstones of No. 5 are much more fully developed in the Cahaba and Coosa Fields, than in the Birmingham section of the Warrior Field. The most satisfactory exhibit is between Shades Creek and the mural crest of Cahaba Mountain. On the road going east from Red Gap these rocks are traversed three miles across the strike. The usual dip on this line is 10 degrees southeast. We crossed the same formation near Trussville, and also near Oxmoor, without observing any differences worthy of note.

The mountain brow overlooking the furnace at Oxmoor is impressive.

At Brock's Gap, a few miles below Oxmoor, two coal seams were observed beneath the Sand Mountain Conglomerate, or Cliff Rock. One of these, close to the rock, was 10 inches in thickness; the other, a little lower, was 4 feet, but had two thick shale partings. Still below these was coal smut, indicating a thick seam. So far as we could learn, no coal has been mined in this part of Alabama—lying below the Sand Mountain Conglomerate. And yet this is the place of the Etna seam, one of the best coal seams in Tennessee and North Georgia, and it is possible that workable seams may yet be developed in this group in Alabama. Nor have we had evidence of the existence of any coal below the Sub-Carboniferous limestone, corresponding with the Montgomery (Va.) seams.

THE SAND MOUNTAIN CONGLOMERATE.

The Sand Mountain Conglomerate, or Cliff Rock, varies lithologically in many respects, and yet at every escarpment, no matter what be the angle of its dip, it shows its face prominently, and leaves no room for doubt as to its identity. This is owing to its combination of hardness with massiveness, and to its position between shales and soft sandstones. Its color is always whitish (so far as observed) and its texture is unusually coarse, though not always so. In some places, as at Boyle's Gap, and Kerr's Gap, it shows a face of 50 to 100 feet, with a strictly conglomerate band of 3 to 10 feet, and shale below and above; but in other places, as at Thompson's Gap, in Coosa Mountain, and especially at Bullard's Shoals, the shales divide it into layers. The layer next above the Sub-Carboniferous, at Thompson's Gap, is a compact sandstone—suitable for fire-rock. This is followed by a band of Conglomerate; this, again, by a band of shale containing iron ore; and a stratum of flaggy sandstone tops the series. The two layers first indicated aggregate about 15 feet in thickness. At Bullard's Shoals, where Valley Creek passes through Sand Mountain, the lowest bed exposed is the iron-bearing shale. Then follow: Conglomerate, 6 feet; a thin dark slate, 10 feet; thin, hard, white sandstone, 18 feet; and then, again, dark slate, 6 feet.

OTHER CONGLOMERATES, AND THE CONGLOMERATE GROUP.

In the Warrior Field we saw at least three bands of conglomerate sandstone, from one to three feet in thickness, at geologic elevations of about 1,000, 1,200, and 1,500 feet above the Sand Mountain Conglomerate. The middle band of these three is a soft, coarse, pale, greenish-yellow sandstone, containing white quartz pebbles about the size of a pea; but with a few of larger size interspersed throughout the mass. It decomposes readily, and its pebbles, lying scattered on high plateaux, may easily be mistaken for drift. Its place in the scale is about 40 feet below the Curry seam. It may be seen in place 200 feet above Rock Creek, at Tilman Salter's; and its disengaged pebbles bestrew the plateau south of Salter's house. They are also found below the river fork, on the west side; and both pebbles, and blocks of the sandstone containing pebbles, may be seen at a deserted house and well north of Glover's Ferry.

The upper band lies about 60 feet below the Pratt seam, and may be seen at David Moore's, near the Milner Mines. It and its accompanying rocks are dark, hard sandstones, closely resembling the lower of the three bands, which lies about 80 feet below the Newcastle seam.

The largest bed we saw of the lower band was near Goggin's Ferry; but we also studied it at Newcastle, where it is well exposed on the creek between the railroad and the Black Creek mines. Here the rocks dip 50 degrees northwest, and are in ledges of a foot or more in thickness, several of which are very pebbly. The rock, itself, is hard, coarse, mixed, black-specked and dark, with an olive tinge. Like most of the sandstones, it is micaceous. There is here, also, a band of soft, yellow sandstone containing pebbles, which range from an inch in diameter to the size of gravel. They are mostly dark, rounded fragments of quartz, but among these are bits of angular sandstone. The pebbly group is about 40 feet.

In the Cahaba Field, among Mr. De Bardeleben's coal seams, we saw a ledge or two of hard conglomerate, and, at a higher elevation, scattered pebbles. On the east edge of the same field, at Helena, is an extraordinary bed of coarse, loose, dirty-looking, sandy conglomerate that is crammed with pebbles; most of these are over an inch—and some are as much as six inches—in diameter. They are generally composed of dark quartz. The pebbly bed is more than 40 feet thick, and passes above and below into argillaceous sandstone. This remarkable bed is seen well exposed at the west end of the railway bridge across Buck Creek. It lies close to the fault which cuts off the Carboniferous series, and pitches against the Silurian limestones. Its position, if there be no inversion, makes it the top rock of the Cahaba series at this place; and it may possibly prove, though this is conjecture, to be the top rock of the Conglomerate Group. We saw no rock of similar character in the Warrior Field, nor, indeed, any that suggested the possibility of its being the top rock, such as is found in Tennessee, Southwestern Virginia and West Virginia.

Fossils seemed nowhere abundant, and those we met with were of familiar types. Dr. Lesquereux located all that were sent to him, from this region, in the Sub-Conglomerate rocks. So far as the localities were indicated, however, they came from horizons above the Sand Mountain Conglomerate, which cannot be understood as being anything but the bottom plate of the Mill Stone Grit, or Conglomerate Group. If this eminent paleobotanist employed as his Conglomerate horizon the *top plate* of the series, which in West Virginia is much the most prominent, we may reconcile his classification with the stratigraphy.

In this connection it may be as well to state that something of a discussion is now going on in the geologic world in regard to a highly important group of coal seams, which formerly received but little attention because it was known to exist, as a source of coal, only in West Virginia and in the States to the southwest of it. The divisions of the Carboniferous scale were first established and named in England, and were endorsed by Northern geologists, who, although highly competent men, were not at that early day intimately acquainted with the peculiarities of the Southern coal fields. Hence, the grouping and nomenclature of the geologic systems which have been and, to a great extent, are still in vogue, are faulty, and particularly as regards the coal series.

The fact is just beginning to be recognized that the Southern field differs greatly from the English, and scarcely less from the Northern field ; and that even the southern half of West Virginia differs materially from the northern half of the same State. The facts pertaining to an important division of the coal rocks in West Virginia were first brought clearly to light by the construction of the Chesapeake and Ohio Railway through the deep—and previously almost unvisited—gorge of New River, between the mouths of the Greenbrier and Gauley rivers. It was already known that the Great Conglomerate, which in New York was only 25 to 60 feet in thickness, was thicker in some parts of Pennsylvania and was parted by slates into two beds; and, also, that one or two small seams of coal belonged here. But, as late as 1856, Prof. J. P. Lesley, of Pennsylvania, now at the head of the State Survey, described the Great Conglomerate as a "white sandstone in two solid beds; upper 15 feet, lower 30 feet thick, with shaly bands between." Recent investigations, notably those of Prof. Fontaine, of the University of Virginia, have in some localities, particularly on New River, West Virginia, enlarged this group to more than 2,000 feet, and have shown it to be charged with numerous coal seams. It is now known as the Inter-Conglomerate or Quinnimont Group. That portion of the formation lying north of New River has never been regarded as being, to any useful extent, a coal-bearing group. But the conglomerate coals along this river have become famous within fifteen years; especially for making iron, after they have been coked. Immense beds of superior coal have also been recently opened in West Virginia and Virginia, in the same group, under the auspices of the Norfolk and Western Railroad. These beds lie along Flat Top Mountain, which runs southwest from New River. Prof. Stevenson identified this group, continuously, into Tennessee, where it has an immense development. Hence, if it should be proved that the Alabama coals belong chiefly to this now celebrated Inter-Conglomerate Group, there will be no ground for disappointment or regret.

But the important question concerning a coal field is not as to its place in the geologic scale, but as to its contents. In approaching the subject of the contents of the Alabama coal field, however, it should be admitted in the outset that no systematic and exhaustive study of the field has yet been made. The State appropriates but $500 per annum for its Geological Survey. Prof. Tuomey, the late State Geologist, and Prof. E. A. Smith, his successor in office, have published valuable reports; but, owing no doubt to certain stratigraphical irregularities, neither has attempted to give a vertical section of the coal measures on his own responsibility. Their reports, however, furnish many useful facts, which greatly aided us in our researches, and Prof. Smith showed the utmost readiness to aid us by all means in his power.

We now turn to the contents of the three coal fields whose area and structure we have sketched.

CONTENTS OF THE COOSA COAL FIELD.

Before the advent of railroads, coal was shipped down the rivers from all the Alabama coal fields, in times of high water, to supply the demand of the Mobile and other markets. This demand, with the prospecting of those universal coal pioneers, the blacksmiths, caused some openings to be made in the Coosa, as well as in other fields. The Confederate Government is reported to have proved by experiment that the very best quality of coking coal is to be found in the Coosa Field. But all the openings we could hear of have caved in, except at one place. So far, coal has been discovered in only the western of the two basins into which this field is divided. The seams lie between Daughdrille's Mountain on the east, and the Conglomerate uplift on the west edge—locally known as Bald Rock Mountain. The width of the basin is about 5 miles, at Broken Arrow Creek. In the space between the two ridges mentioned are two other leading ridges, which divide the whole space somewhat equally. These intermediate ridges are called No Business Ridge (next to Daughdrille's Mountain), and Sand Ridge, and are composed of sandstone and shales of varying texture and color. Two or three miles northwest of Eden (near the Georgia Pacific Railway) we visited Inzem's coal-pit, where the seam is said to be 3 feet thick, but water prevented us from examining it. In the same neighborhood we saw coal sign in the road, and pits near George Stephens'; we also heard of coal diggings at Bowman's, Black Angle, &c., but not of any exposed seam.

The mining for river shipment was done, chiefly, from three to five miles north of the railway line, on No Business Creek, a branch of Broken Arrow. This little stream is at the west base of No Business Ridge; and here, undoubtedly, is a very fine seam of coal, which we saw and measured. It is 4 feet 2 inches thick, where we found it in an old drift. We also saw the coal freshly thrown out of a pit at another opening, and a more beautiful, black, shining coal one would not desire to see. It is columnar in structure, and rather friable for stocking, but exactly suited to coking. We observed neither slate nor sulphur in this coal. This seam is manifestly one of great value. Prof. Tuomey states that he found two seams on Broken Arrow Creek, each containing 5 feet 2 inches of clear coal. Mr. T. H. Aldrich, in Prof. Smith's Report for 1875, says of this field: "There are three seams known, the thicknesses of which are 3 feet, 3 feet 6 inches, and 4 feet." It is reported that Maj. Howell found a 9-foot seam in the Coosa Field. It is quite certain that the Coosa Field deserves a sort of study which it has not yet received.

THE CAHABA FIELD.

Systematic mining was commenced in the southern part of this field as early as 1853, and gradually moved up to the line of the

South & North Alabama Railroad, between Helena and Brock's Gap. Mines are still in operation on this line, and south of it; but, so far as we could learn, the field north of this line has been, until very lately, wholly neglected by mining companies, owing to its heretofore inaccessible location. There is every reason to believe that the seams which are found along the South & North Railroad are continued north, and will be crossed by the Georgia Pacific Railway. Explorations lately made indicate plainly that the seams where crossed by the surveys have lost nothing of their fulness or their excellence.

Geological Section, No. VI., across the field of the South & North Railroad, was made by Mr. Richard P. Rothwell, Mining Engineer; and was embodied in an article written by Mr. T. B. Aldrich, and included in the report of Professor Smith, for 1875.

The basal Cliff Rock, as seen at Brock's Gap near Oxmoor, on the west edge of the Cahaba Field, is a mass of hard sandstone nearly 100 feet thick, with small pebbles near the top; whilst the coal series, except perhaps the Helena seam, is overlaid on the east edge by the heavy bed of coarse conglomerate heretofore mentioned. The Helena seam is said to overlie this coarse bed of rock. Mr. Rothwell, who spent the greater part of three or four years in studying this field, states that there are on this line seven or eight workable seams of clean coal, varying from two to seven feet in thickness. He assumes that, whilst there is some crumpling of the rocks near the middle, the general structure of the field is a monocline. The dip varies from 10 degrees to 90 degrees in moving from west to east. He states, also, that the seams are generally free from slate partings, and gives the following numerical list, which shows the order of their position—commencing with the highest, on the east. Mr. Aldrich supplied the accompanying names, which show that two of the numbers belong to the same seam:

		Thickness.	
9.	Helena seam	4 ft.	0 in.
8.	Conglomerate or Beaver Dam seam	3 “	6 “
7.	Little Pittsburg seam	2 “	0 “
6.	Maple seam	2 “	0 “
5.	McGinnis or Black Shale seam	2 “	6 “
4.	Buck seam	3 “	6 “
3.	Cahaba seam	3 “	3 “
2.	Cahaba seam	4 “	0 “
1.	Gould seam	3 “	6 “

Mr. Rothwell also had the coals analyzed from samples, which, in the main, were selected so as to give a fair average of the seams.

CAHABA COALS.—R. P. Rothwell.

	Cahaba Seam, Davis Mine.	Cahaba Seam, Holt Mine.	Black Shale Seam. (McGinnis.)	Moyle Seam.	Little Pittsburgh Seam.	Conglomerate Seam.	Helena Seam.	Gould Seam.	Mean of 14 Analyses of Cahaba Coals from 8 Seams.	Mean of 14 Analyses of Indiana Coals; Cox.	Mean of 6 Analyses of Ohio Block Coals; Newberry.
Specific Gravity	1.22	1.29	1.29	1.38	1.29	1.28	1.12	1.30	1.26	1.24	1.266
Moisture	1.66	1.58	1.91	1.93	2.05	2.13	2.54	1.34	1.98	5.2	4.54
Volatile Combustible Matter	33.28	32.60	32.65	32.84	33.47	30.86	29.44	28.96	31.47	34.8	34.61
Fixed Carbon	63.04	62.62	63 91	59.64	62.20	64.54	66.81	60.58	63.92	57.2	58.68
Ash	2.02	3.20	1.53	5.59	2.28	2.47	1.21	9.12	2.63	2.6	2.17
	100.	100.	100.	100.	100.	100.	100.	100.			
Sulphur as Sulphate	.097	.233	.071	1.001	.118	.320	.073	0.09	1.06	....	0.87
Sulphur as Sulphuret of Iron	.428	.727	.559	2.779	.523	1.160	.455	0.73			
Sulphur in Coke	....	....	....	....	....	... ...	.214	0.21	....	....	....

These analyses certainly make a fine showing for Cahaba coals, the different seams exhibiting qualities well suited to all purposes.

The width of the Cahaba Field along the line of the Georgia Pacific Railway is about the same as along the line expounded by Mr. Rothwell. We observed some, but no decided change of dip—except in its increasing steepness toward the southeast, in which direction it gradually falls from 10 degrees to 30 degrees, or more. The indications pointed to a folding back of the southeast margin, and consequent duplication of the coal seams. Lookout Mountain, which is the northern prolongation of the Cahaba Field, is a simple syncline, and on its southern prolongation the trough gradually becomes deeper, and ultimately double; the east flank, as usual, being the more disturbed.

Near the east margin of the field, at a point north of Moody's Cross-roads, we saw a bed of coal (with slate partings) 12 feet thick, under which were three other beds. Near Dorough's, which also is close to the east edge, we were shown a 5-foot seam of good coal, with two partings of fire-clay—each one inch thick. We also saw numerous partial exposures on Snake Branch, where a party of men in the employment of Mr. DeBardleben were systematically digging into seams whose outcrops appear as steps on the face of the high mountain which rises from the southeast side of the Cahaba River. Here seems to be presented just the condition of things indicated in Mr. Rothwell's section, near the east side of the field, namely, numerous adjacent coal seams pitching with a high dip to the southeast.

The prospecting party was in charge of Mr. Hugh Freel, who gave us the following rich section which he claimed to have just proved by actual openings and measurements. He had begun operations a short distance from the river, and had followed Snake Branch, which cuts pretty squarely across the formations, but had not yet reached the top of the ridge; he claimed that there were still two seams, at least, to be opened above those reported in the section, which would make thirteen seams on one mountain side.

FREEL'S SECTION OF COAL SEAMS SOUTHEAST OF CAHABA RIVER, NEAR GEORGIA PACIFIC RAILWAY.

Descending.

		Thickness.	
11.	Coal	6 feet	6 inches.
	Rock, including slate	30 “	
10.	Coal	5 “	
	Rock	12 “	
	Conglomerate	30 “	
9.	Coal	4 “	
	Rock	100 “	
8.	Coal		18 inches.
	Rock	30 “	
7.	Coal	3 “	
	Rock	30 “	
6.	Coal		6 inches.
	Rock	20 “	
5.	Coal	1 “	
	Rock	15 “	
4.	Coal, same level as 9-foot seam, in another hollow	6 “	
	Rock	40 “	
3.	Coal		18 inches.
2.	Coal in five bands, separated by fire-clay	3 “	
	Rock	100 “	
1.	Coal (fork of Snake Branch)		6 inches.
	Total	480 feet.	

Mr. Freel stated that the same series is found on Shop Branch, and that a number of good seams exist west of Cahaba River.

The evidence from all quarters warrants the statement that there are in the Cahaba Field numerous workable seams of good quality—an unusual proportion of which are of goodly thickness and free from slate, and that the coals being varied in character are adapted to all important uses.

THE WARRIOR COAL FIELD.

The Warrior Field is now attracting most attention, on account of its extent, its excellent coal, its nearly horizontal strata, and hence its cheap mining. The dip will not average so much as 5 degrees; usually it does not exceed 3 degrees, which is better for mining than an exact level. Along the east margin, however, as already mentioned, the dips are high; though, with the exception of one line of fault, we do not recollect to have seen any workable coal dipping at a greater angle than 20 degrees. The steep dips are short. The lack of exposures, and the obscurity occasioned by the folded and fractured condition of the margin, which is the base line of comparison, seem to have deterred observers from undertaking to construct a vertical section. The only published section was first embodied in the Alabama State Report of 1877 and 1878; was repeated in the Report of 1879 and 1880, and has been frequently copied by reporters. This section was prepared by Mr. T. H. Aldrich, a mining engineer, who has been an observant and useful pioneer in the Alabama Coal Field for many years. Our observations, however, led us to think that some revision of this section was needed, and we wrote to Mr. Aldrich, making some criticisms, and inquiring whether his longer experience had thrown more light on the problem. He responded promptly and politely, and said as to the main point: "In regard to the section you speak of as having been made by me, I will premise that it did not claim to be anything more than *an attempt*, and was the result of only limited work done for the Pratt Coal and Coke Company. *The duplication of seams does occur*, and was caused by a fault making *an actual* duplication, which can be seen on Black Creek." Concerning another point, he adds: "I was deceived in regard to about three seams below the Pratt." He then gives a list of the coal seams above the Newcastle, but does not say what changes he would make in the accompanying rocks. We may not yet be able, therefore, to give his section exactly as he would give it; but will reconstruct it, as well as we can, so as to give him the benefit of his own corrections. The scale between the Pratt and Newcastle seams is thus shortened by about 325 feet.

MR. T. H. ALDRICH'S GENERAL SECTION OF THE WARRIOR BASIN, WEST OF BIRMINGHAM.

Surface Soil of variable depth.

Coal—*Guide seam*	0	ft.	3	in.
Sandstone and shale	115	“		
Coal—*Pratt seam*	4	“	6	“
Sandstone, &c	20	“		
Coal—*Sixteen-inch seam*	1	“	4	“
Sandstone and shale	30	“		
Coal—*Four-foot seam* in two benches of equal thickness, with 8-inch slate parting	4	“	8	“
Sandstone and shale	50	“		
Coal—*Slaty seam*	1	“	6	“
Sandstone, &c	35	“		
Coal—*Double seam*, 8-inch and 15-inch, with 5 feet of shale between	7	“		
Sandstone, &c	100	“		
Coal	2	“	2	“
Shale, &c	50	“		
Coal—*Double seam*, thickness not known				
Sandstone, shale, &c	300	“		
Coal—*Newcastle seam*	5	“	8	“
Sandstone, &c	15	“		
Coal—poor	1	“	10	“
Fire-clay, 3 feet; and sandstone, 20 feet	23	“		
Coal	2	“	6	“
Sandstones, &c	25	“		
Black Band Iron Ore	1	“	4	“
Sandstones	20	“		
Coal—poor, full of slate	4	“	9	“
Fire-clay and arenaceous clays	20 to 30	“		
Conglomerate	16 “ 20	“		
Coal—with shale	1	“	6	“
Sandstones and shales	81	“	10	“
Coal—good, hard	1	“	6	“
Sandstone	40	“	6	“
Coal—good, *Jefferson seam*	3	“	3	“
Sandstones, &c	29	“	5	“
Coal—good, *Black Creek seam*	2	“	6	“

SECTION BELOW BLACK CREEK SEAM.

Sandstones, &c	139 ft.	
Coal—doubtful	1 “	6 in.
Sandstones, with fossil shells	85 “	
Coal	1 “	2 “
Sandstones, &c	30 “	
Cannel Coal and *Black Band*	2 “	4 “
Slate, hard	4 “	
Coal—good, *Warrior seam*	2 “	9 “
Clays, sands, &c	20 “	5 “
Coal	1 “	“ 8
Clay and sandstone	7 “	6 “
Coal—hard	2 “	2 “
Shale and sandstones, &c	295 “	6 “
Coal—hard and bright	1 “	6 “
Sandstone and fire-clay	17 “	
Coal	1 “	4 “
Shales with coal plants	12 “	
Coal—good	2 “	6 “
Sandstones, clays, &c	102 “	7 “
Shales and sandstones, with two thin seams of coal near bottom of the series	450 “	
Silicious sandstone, often a conglomerate, base of coal measures	100 “	

Below these follow:

Sub-Carboniferous St. Louis Group:	Shales	80 “
	Limestones with Pentremites	75 “
	Silicious sandstones	60 “

The following section of the Warrior Field, prepared by Mr. Howard Douglas, of the Milner Coal and Railroad Company, and endorsed by Mr. John T. Milner, has not been before published; it begins with the top seam and ends with the Black Creek seam. These gentlemen spent several years in the study of the field, with a view to the opening of the coal mines.

MR. DOUGLAS' SECTION OF THE WARRIOR COAL FIELD.

Descending:

1.	Shale	100 ft.	
2.	Coal		12 in.
3.	Shaly sandstone	40 "	
4.	Coal		8 "
5.	Heavy boulder sandstone	10 "	
6.	Shale and sandstone	200 "	
7.	Coal—*Pratt seam*	4 "	
8.	Boulder sandstone	10 "	
9.	Shale	20 "	
10.	Coal—*Fire-clay seam*	1 "	6 "
11.	Fire-clay	1 "	6 "
12.	Shale	25 "	
13.	Conglomerate sandstone	10 "	
14.	Shale	5 "	
15.	Coal 1 ft. Clay 6 in. Coal 1 " *Double seam*	2 "	6 "
16.	Gray sandstone	60 "	
17.	Coal 2 ft. 6 in. Rock 30 " Coal 1 " 8 " Rock 30 " Coal 2 " Rock 30 " *Jack's seams*	96 "	2 "

[NOTE.—There are several seams of kidney ore in the Jack Group. The rocks are yellow sandstones and shales.]

18.	Coal—*Curry seam* (2 ft. 4 in. to 3 ft.)	3 "	
19.	Sandstones	50 "	
20.	Coal and shale—*Campbell seam*	8 "	
21.	Sandstones	140 "	
22.	Coal—slaty—*Freel seam*	3 "	
23.	Sandstone, hard, gray, micaceous	2 "	
24.	Hard slate and sandstone	48 "	
25.	Coal—*Newcastle seam*	6 "	
	[Kidney ore.]		
26.	Slate and sandstone	20 "	

[Kidney ore.]

27.	Coal—*Alsop seam* (2 ft. 6 in. to 3 ft. 6 in.)	3 ft.	6 in.
28.	Sandstone, massive, hard, light gray	10 "	
29.	Coal	*a trace*	
30.	Slate and sandstone	15 "	
31.	*Black Band Iron Ore*	1 "	4 "
32.	Dark slate	1 "	8 "
33.	Sandstone, gray, very hard	3 "	
34.	Conglomerate (3 ft., pebbly)	30 "	
35.	Coal	1 "	
36.	Fire-clay	2 "	
37.	Heavy sandstone	25 "	
38.	Yellow shale and sandstone	80 "	
39.	Coal—*Peacock*	1 "	8 "
40.	Sandstone and slate	30 "	
41.	Coal—*Peacock*	2 "	
42.	Sandstone and slate	40 "	
43.	Coal—*Black Creek seam*	2 "	8 "

Mr. Aldrich and Mr. Douglas conducted their studies independently of each other, and yet they agree closely enough to show that we are getting near the truth in respect to the Warrior measures, as far down as the Black Creek seam. The following brief table shows how nearly their estimates coincide.

	Aldrich.	Douglas.
Pratt seam to Curry seam	256 ft.	238 ft.
Curry seam to Newcastle	356 "	257 "
Newcastle, to Black Creek	304 "	268 "
Total seam from Pratt to Black Creek	916 ft.	763 ft.
Total number of coal seams	15	14
Seams 2 ft. and upwards	8	10

As to the rocks overlying the Pratt seam, Mr. Douglas gives a thickness of 350 feet, which is undoubtedly correct. Mr. Aldrich gives 115 feet, but his letter shows that he is now aware of the greater thickness.

Concerning the coal seams which lie below the Black Creek seam, we have no personal knowledge. The developments that have been made in the Warrior and other seams supposed to lie below the Black Creek seam were so far north of the line of the Georgia Pacific

Railway that we did not visit them. We saw at other points, however, signs of coal in the strata underlying the Black Creek seam. The determination of the thickness of the series between this seam and the Sand Mountain conglomerate is embarrassed by a line of vertical slates which run a few hundred yards west of, and parallel to Sand Mountain, but which are so masked as to leave the structure problematical. The indications are that the rocks next to Sand Mountain lie in a closed synclinal fold, which is followed, perhaps, by a sharp anticline; next to this, again, is a fault, and west of the fault the strata dip gently to the northwest. A thousand feet from the Black Creek seam to the Sand Mountain conglomerate is probably a liberal estimate.

SOME GENERAL NOTES ON THE ROCKS OF THE WARRIOR COAL FIELD.

The whole series of coal-bearing rocks in this field is divided into six or more groups, so nearly repeated that they cannot be distinguished lithologically except in the case of the Newcastle and Pratt groups, which are characterized by extra heavy, dark shale beds, and flaggy gray sandstones. These various rock groups seem to base themselves on the leading coal seams, and on the conglomerates. Among the slates overlying the Black Creek, the Newcastle, the Pratt, and probably other seams (and sometimes underlying them, also), is a singularly hard, flaggy sandstone, of a bluish, steel gray or "pepper and salt" color, the black specks being, apparently, mica. Over this is a pile of flags, composed of dark olive-green, hard, micaceous, somewhat coarse-grained sandstones, which are often seen showing wide flat surfaces in the streams. Next above these usually comes a light apple-green, moderately hard, sandstone; and over this a coarse, loose sandstone, of a yellowish color when not exposed, but weathering deeply into an orange-red mass of half decomposed rock. This passes into an arenaceous, ferruginous shale, often holding brown silicious iron ore. Above this, and usually forming the top soil of the plateaux on the tops and benches of the ridges, is an orange-red, sometimes even carmine colored shale. These groups range from 50 to 150 feet in thickness, respectively, and in some cases exceed even 150 feet. The top shales of the Curry group are more sandy than the corresponding shales of the other groups. The Newcastle and Pratt shales make the best soils. Some beds of hard, gray sandstone weather brown into rounded, and concentric protuberances, and may be used as guides to certain coal seams.

Iron ores are found at numerous horizons among the coal-bearing rocks. Generally they are brown, and reniform or lenticular. We saw no hematite in workable beds, but good beds may exist. It is probable that the ore beds in the Sand Mountain conglomerate will prove valuable. The beds we saw in this conglomerate, on Coosa Mountain at Thompson's Gap, on Cahaba Mountain at Foster's, and on Sand Mountain a mile north of Valley Creek, would now be exciting attention but for larger deposits hard by.

The black-band ores are promising. About 50 feet below the Newcastle seam is a bed of 16 inches of good black-band ore, which is used to some extent by the iron furnaces on account of its argillaceous character. We saw this bed at the Newcastle mines, and also near Valley Creek. It is reported to be three feet thick in some places. Mr. Aldrich's Section gives two distinct beds of this ore.

THE COAL SEAMS, AND COAL MINING, IN THE WARRIOR FIELD.

The outcrops of all the coal seams are found within two miles of Sand Mountain, and, unless the Pratt be an exception, all the workable seams of the series bespread themselves over the entire Warrior Coal Field along the line of the Georgia Pacific Railway. This railway crosses the entire series, including the Pratt seam. The first railroad that entered any part of the Warrior Field was the South & North Alabama Railroad, which was completed in 1872; hence, the first mines were north of Birmingham. This road passed through Sand Mountain at Boyle's Gap, and, crossing the Locust Warrior going north, entered the head of Blount Valley at Reid's Gap, thus diagonally traversing the east basin of the Warrior Field. Almost immediately following the completion of the road, five mining companies commenced operations in this field—three of them north of the Warrior River, and two south. The northern mines are in the Warrior seam, which is represented to be from 2 feet to 2 feet 6 inches in thickness; the coal is rather soft for stocking, but is good for steam and forging purposes. A short distance south of the river bridge, the Jefferson seam was entered upon. But the largest operations on this railroad have been carried on by Messrs. John T. Milner & Co., at Newcastle station, 10 miles north of Birmingham. Here two seams have been worked, namely; the Newcastle, 5 feet 8 inches, and the Black Creek, 2 feet 8 inches. Only the latter, which supplies a coal of extraordinary excellence, is worked at present. It is free from slate, and easily mined. Its dip is northwest 30 degrees, at the outcrop, but diminishes rapidly to perhaps 5 degrees. Its evaporating power is 8.01 pounds of water to the pound of coal. It yields 4.82 cubic feet of gas to the pound, and 33⅓ bushels of screened coke to the ton. As a gas coal it is very superior; and a test made at Louisville showed it to be superior to the Pittsburgh coal as a steam generator. The evidence as to its value for fuel, and for blacksmiths' use, is equally decided. The proportions of ash, sulphur, and clinker are very small. The cost of this coal, deposited on the platform at the railroad, is one dollar per ton.

ANALYSIS OF THE BLACK CREEK COAL, BY PROF. N. T. LUPTON.

Specific gravity	1.29
Moisture	1.36
Volatile matter	31.79
Fixed Carbon	64.71
Ash	1.82
Sulphur	.32

The Newcastle seam was worked successfully for a number of years. In many respects, this is the most important coal seam in the Warrior Field. Its average thickness is greater than that of any other. In some places it exceeds nine feet, and, although variable, is of workable thickness wherever found. Hence it may usually be mined very cheaply. Its available area is far greater than that of any other seam. Whilst the quality of the coal varies, its average is good, and in many places superior. The only drawback is in the slate seams, owing to the presence of which other seams are now having the preference; but, unquestionably, there is a great future before the Newcastle seam. Machinery for washing out the slate from coal is now largely used, and machinery for cutting it out in the mine will no doubt be invented.

This coal is found on both branches of the Black Warrior River; and, before the coming of railroads, was shipped by water to Mobile and elsewhere, and found ready sale at remunerative prices. In some places it is firm, bright and free burning; breaks but little in handling; and it is better in fact than the coal of the same seam on the eastern outcrop.

Although the mine at Newcastle is not now worked, the

Alabama Great Southern Railroad is said to have used this coal exclusively in its locomotives for years, and there are highly favorable letters on file from locomotive engineers, regarding its value. We have also seen a statement from the South & North Alabama Railroad Company, showing that 1,120 bushels of this coal ran a locomotive 4,500 miles. We give below a copy of an emphatic letter from the large iron manufacturer, Mr. James Noble, Sen., which testifies as to the suitability of this coal for foundry, machine shop, and rolling-mill purposes:

ROME, Geo., Apr. 20th, 1874.

JNO. T. MILNER, ESQ.,

Sir: Of the sixteen car loads of your coal sent us, two were turned over to Noble, Bro., & Co., and used in our Machine [shop] and Foundry. Nine more have been used by us in the Rolling Mill at this place. The coal answers all of our purposes well, and is equal to, if not superior to, any coal used by us for heating or steam purposes. We prefer your coal to any we have been using.

Very respectfully,

JAMES NOBLE, SEN.

Supt. R. I. M. Co.

In his book on Alabama, p. 174, Mr. Milner gives the following account of the mining on this seam prior to 1876: "Operations were commenced first on this seam by the Newcastle Coal Company, and some 200,000 tons have been mined and sent to market from this vein. This vein is 5 feet 8 inches thick, including two hard strata of slate near the middle, of two and three inches thickness, inclosing about 5 inches of coal. The bearing in, or mining, is done between these two slates, and being hard, they interfere but little with the clear mining of the coal. A slope has been sunk 600 feet, inclining northwestwardly about six degrees at the surface, and coming at the bottom to less than one degree, or nearly on a level. It is mined more cheaply than any other coal in Alabama, and a part of a cargo was shipped to Havana in 1873, and gave great satisfaction in that market, netting the miner here $2.00 per ton for the coal."

The analysis of this coal as found at Newcastle makes a fair showing, but does not equal that of some other parts of the same seam. The analysis by Dr. Otto Wuth, of Pittsburgh, Pa., shows the following composition:

Specific gravity	1.38
Water	.50
Volatile matter	28.24
Fixed Carbon	59.69
Ash	10.92
Sulphur	.64

Along the Warrior Rivers and in the western part of the field the same seam, or what we regard as the same, has been opened at different points, a number of which make a better showing than the original mine at Newcastle. There is an extraordinary coal bed on the Locust Warrior, two miles below the mouth of Village Creek, owned by Mr. Calvary Williams. Dr. Smith, the State Geologist, gives the following measurements of this bed:

Coal	1 ft. 3 in.
Clay	0 " 2 "
Coal	0 " 4 "
Slate	0 " 3½"
Coal	2 " 3 "
Slate	0 "10 "
Coal	4 " 0 "
(1 ft. 6 in. showing above water level.)	
Gritty slates	10 ft. 0 in.
Lower Group:	
Coal (main bench)	5 ft. 6 in.

Dr. Smith gives also the following analyses of the main benches of this coal. No. 1 is from the four-foot bench of the Upper Group, and No. 2 is from the main bench of the Lower Group:

	No. 1.	No. 2.
Specific gravity	1.391	1.312
Sulphur	.521	.604
Moisture	4.175	1.525
Volatile matter	22.415	26.170
Fixed Carbon	62.482	66.020
Ash	10.928	6.285
	100.000	100.000

There is a bed of coal near Democrat—where it may be seen in Morgan's well, and on the adjoining land of Jas. Hawthorne—

which is of such admitted excellence that it has been generally regarded as the Pratt seam; and this opinion is countenanced by the State Geologist (Reports of 1879 and 1880, p. 61), who analyzed the coal and called attention to the similarity between its analysis and that of the Pratt coal at Coketon. The bed at that time was exposed to a depth of but 4 feet, which was considered its full thickness. Visiting this locality, and finding that the stratigraphy pointed to the Newcastle rather than to the Pratt seam, we caused the bed to be uncovered more deeply, until we had exposed a thickness of 7 feet 3 inches. The coal presented the appearance, as well as the thickness, of the Newcastle bed. Dr. Smith's analysis shows an excellence but little below that of the Pratt seam.

ANALYSIS OF JAS. HAWTHORNE'S COAL.

Specific gravity	1.333
Sulphur	0.516
Moisture	2.969
Volatile matter	29.784
Fixed Carbon	60.598
Ash	6.649
	100.000

Before considering the Pratt seam, we will make some general remarks on

THE WEST WARRIOR COAL FIELD.

If we except the digging done by blacksmiths, and the unsystematic gathering of coal for river shipment, there has been no mining done west of the Locust Warrior; and there can be none until railroad transportation is supplied. We are left, therefore, to judge the coal by its weathered outcrops and partial exposures, and are wholly without results of the only infallible test, namely, the actual use of the coal on a large scale, and in varied operations. As already stated, the same series that is found partially developed on the east margin of the field is continued to the extreme west margin, near Fayette C. H. We did not meet with the Pratt (the top) seam beyond the Warrior; but we cannot affirm that it is not there, and intelligent students of the field claim to have identified it at different points.

The structure of the plateau between the rivers heretofore described renders it almost certain that, with the modification just mentioned, the Newcastle, Black Creek, Jefferson and other seams which have been worked in the Warrior Field could here be reached at a small depth; and it is possible that their outcrops might be readily uncovered. We refer, particularly, to the Democrat Valley, and to the plateau region south of Democrat—where the crest of the anticline has been cut off so deeply as to leave but little covering on the underlying Sand Mountain conglomerate. On the flanks of the anticline, in the waters of both the Warrior rivers, and in the waters and on the banks of all the creeks and rivers we visited west of the Warriors, we saw exposures of coal of varying quality, and of almost every thickness from 3 inches to 8 feet. Among the thicker western beds are Obe's Creek, 8 feet; Democrat, 7 feet; Mount Carmel, 6 feet; and Townley, 7 feet. Exposures of 3 to 5 feet are common.

Fifty miles west of Birmingham we found extensive preparations for mining going on under the conduct of Major W. J. Kelly, who has associated with him a body of capitalists residing in Columbus, Miss. The mine will be in the Gaines seam, on Wolf Creek, which shows a good face of 42 inches. It is hoped that the railway, which is approaching from the West, will reach Wolf Creek next spring; and Major Kelly announces his intention of sending a coal train to market by the first locomotive. As this coal will soon become known we give the following good analysis, which was made by Prof. J. L. Campbell at the laboratory of Washington and Lee University, from a vertical section of the seam:

Analysis of the Gaines Coal.

Coke	60.714
Sulphur (in coal)	1.953
Specific gravity (of coal)	1.317
Moisture (dried at 110°, C.)	1.551
Volatile combustible matter	37.735
Fixed Carbon	58.811
Ash (reddish)	1.903
	100.000

A few miles east of the Gaines bed we visited Thos. Bradley's coal bed, which is of excellent quality, as is shown by Dr. Smith's analysis:

Analysis of Thos. Bradley's Coal.

Specific gravity	1.278
Sulphur	0.690
Moisture	2.702
Volatile matter	29.564
Fixed Carbon	64.818
Ash	2.916

It will probably turn out that some of the West Warrior seams vary considerably in thickness and in quality, but not more than many well-known first-class seams. The famous Pittsburgh seam, for example, is of double the thickness at Connellsville that it is at Pittsburgh, and is of much better quality at the first named place. In fact, this great seam, which is 12 feet thick at Connellsville, thins to the south and west, and changes character until it loses its value. A like change occurs in the character of the well-known Campbell's Creek six-foot seam, on Kanawha River, West Virginia, whose whole area as an important seam does not exceed 3,000 acres, outside of which it becomes thin and slaty. And like variations are seen in the Quinnimont seam, West Virginia, and in the Sewanee and Etna, the best seams of Tennessee.

But, concerning all the beds of the West Warrior coal field, it is proper that, with our present knowledge, we should express ourselves in a somewhat general way. There is certainly a vast amount of coal of workable thickness in this section, and, when the Georgia Pacific Railway furnishes transportation, a large coal trade will undoubtedly be promptly developed from the western part of the Warrior coal field.

THE PRATT SEAM.

This seam is most convenient to Birmingham and to the present lines of transportation, and is largely used for iron smelting and miscellaneous purposes. In November last the daily output from the mines on this seam was 2,300 tons. This is surprising, considering that it has been only three or four years since the seam was first tapped for systematic mining. The only mining so far has been done by the Pratt Coal and Coke Company, whose daily product is about 2,000 tons, and by the Milner Coal and Railroad Company, whose product is 300 tons.

The Pratt Company's mines are on the east outcrop of the seam which runs nearly parallel to Sand Mountain, from one to two miles in its rear, and about five miles west of Birmingham. This company mine from one vertical shaft; two inclines or slopes from which go down the seam at a dip of perhaps 20 degrees for a few hundred feet, and then, after a short level, at the rate of 6 degrees, which is the usual dip of the seam on this side of the basin. A drift has also been opened in a hollow and enters on the flank of the seam, thus giving a main entry nearly on a level. The mining appliances are of the most modern description, and on the largest scale; and the practical mining is, in every particular, done in the best manner. We have heard of no trouble from water, bad air, or bad roof. The screenings are coked at the mines. The company owns its railroad and rolling stock, by means of which it delivers coal and coke to the Birmingham furnaces and mills, and to the two railroads passing through that city. The cost of mining is believed to be 85 cents per ton, delivered in cars at the mouth of the mines.

The Milner Company is a new enterprise opening on Five Mile Creek, eight miles from Birmingham, where this bold creek has cut across the basin at a level below the horizon of the Pratt seam. The company have selected for their operations the lowest line of the synclinal depression, where the outcrops created by the excavations of the creek are scarcely above high water. Numerous openings have been made, and when we left there in November three entries were being driven on the north side of the creek, and one on the south. A few weeks after commencing operations the daily product reached 300 tons, and, no doubt, will soon be increased. The appliances for mining are on the same plan as those of the Pratt Company, but were incomplete. The company owns a railroad, 10 miles long, to Birmingham.*

The Pratt seam, taking the whole field, averages about 4 feet in thickness, the extremes being about 3 feet and 5 feet. The thickness increases toward the southwest. The roof is generally a firm slate, and in rare cases hard sandstone; the bottom is a fire-clay or soft shale

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***Note—The Milner Railroad and Coal property was recently purchased by The Richmond and Danville Extension Company; which company has conveyed the railroad to the Georgia Pacific Railway Company, and has subscribed the coal property to the capital stock of the Coalberg Coal and Coke Company.**

for 2 feet before reaching sandstone. Besides numerous weathered outcrops, we saw and measured the face of this coal in 22 scattered openings, in only three of which the coal had suffered from the weather, and in these but slightly. We found certain characteristic features which are rarely wanting. One of these is a band of slate—usually about 2 inches thick, but sometimes more, and sometimes less—6 or 7 inches from the top. In mining, wedges are driven under this slate, which is then stripped off and thrown aside. Near the bottom of the seam there are often found a few inches of flaky, bituminous shale, called "rash" by the miners, which is convenient for bearing in, unless, as is sometimes the case, 4 or 5 inches of good coal occur below it. Bony coal occurs rarely, while bands of one to two inches of pure mineral charcoal are common. Thin bands of slate and "knife partings" are not uncommon, but are not uniformly present. Quarter-inch seams of sulphur in pyrite are often found, and this mineral is always present in small quantity. The pyrite is concretionary, and quite irregular as to the place or length of its deposits. We saw but little of the lumpy, sulphurous matter, vulgarly called "nigger head."

The Pratt coal, in its bed, shows the side and end, or "face and butt" structure, more decidedly than any coal we ever examined. It is not strictly columnar, but has a vertical, flaggy structure, which causes it to split off from the face in board-like sheets, and to break up into flat blocks. This peculiar structure renders mining on the butts more difficult than on the face. Fortunately, the dip of the rock and the face of the coal may both be managed so as to suit the miner.

The texture, density and color of this coal, and the character of its contained impurities as well, vary considerably in different parts of the field. Some of it is compact, lustrous and very black, and comes out in blocks of good size for shipping purposes—those of extra size suffering little reduction in dumping and screening; but, generally, its lustre is not so decided, and its texture is such that it is reduced at the dump and in all subsequent handlings. This friability is, indeed, one of its special recommendations as a coking coal, experiments having proved that the finer the coal the more perfect the coking process. It also cakes in burning, which property gives it an advantage over dry, compact coals, since these may contain a large proportion of fixed carbon, and a sufficient proportion of volatile matter, and yet not make good coke.

The laboratory has not yet discovered the law of coking susceptibility. Some of the best English coking coals have but 8 per cent. of volatile matter, with 83 of fixed carbon; whilst the Connellsville coal has 31 per cent. of volatile matter, and 60 of fixed carbon. And so, also, some of the best dry, non-caking coals of Pennsylvania contain more volatile matter than the Connellsville coal. There is something in the manner in which the gases are combined that determines the coking property in coal, and chemical analysis does not point this out.

The only sure test is a trial in the oven and in the furnace. The Pratt coal has borne this conclusive test satisfactorily, and is now actively demonstrating its excellence in many iron furnaces. Analyses are often of doubtful value, because of a failure to state how the sample was selected. Choice lumps prove but little. The samples which we have used for test purposes were taken from the face of the seam by a vertical cut from top to bottom, omitting only what is thrown out in mining, and were analyzed by Prof. J. L. Campbell, in the laboratory of Washington and Lee University. It is possible, of course, that all the analyses we quote herein were made from samples selected with equal care.

ANALYSES OF PRATT COAL.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity	1.300	1.29	1.323	1.295	1.289
Sulphur	0.918	0.47	1.696	1.203	0.824
Moisture	1.501	1.07	0.935	0.855	0.766
Volatile combustible matter	31.485	32.08	30.508	30.745	36.027
Fixed Carbon	61.598	64.30	65.543	65.075	60.333
Ash	5.416	2.08	3.014	3.325	2.874
Analyst	H. McC.	N. T. L.	J. L. C.	J. L. C.	J. L. C.

Samples No. 1 and No. 2 were from the Pratt Company's mines; No. 3 from the Milner Company's mines; No. 4 from Drinking Branch; and No. 5 from New Found Creek. The initial letters appended to the several analyses represent the names, respectively, of Prof. Henry McCalley, of the University of Alabama; Prof. N. T. Lupton, of Vanderbilt University; and Prof. J. L. Campbell, of Washington and and Lee University.

COMPARATIVE ANALYSES OF COALS.

	Fixed Carbon.	Volatile Combustible Matter.	Ash.	Sulphur.
Pratt (average), Ala.	63.369	32.169	3.341	1.022
Connellsville, Pa.	59.620	31.360	8.230	.784
Etna, Tenn.	65.000	32.500	2.500	Trace.
Quinnimont, W. Va.	75.890	18.190	4.680	.300
Flat Top, Va., and W. Va.	73.728	20.738	3.984	.618

These are the standard coking coals of their respective States, except as to the Flat Top, which, though promising, has not yet passed its furnace examination. The cokes analyze as follows:

ANALYSES OF COKE.

	Fixed Carbon.	Ash.	Sulphur.
Pratt	93.01	6.83	.57
Connellsville	87.26	12.00	.74
Etna	82.31	16.18	.84
Quinnimont	93.11	5.94	.82

These analyses, which are supported by furnace tests, demonstrate the excellence of the Pratt coal as a coking and manufacturing coal.

THE LIMITS AND STRUCTURE OF THE PRATT COAL FIELD.

So far as is known at present, the area of the Pratt seam in the East Warrior Basin is less than 100 square miles. Its northeast corner is found in Section 23, Township 15, Range 3, at a point about 3 miles west of Sand Mountain, and nearly west from Newcastle; thence it follows a nearly straight course toward the southwest, but gradually approaches Sand Mountain, so that by the time it reaches Coketon the outcrop and the mountain are less than a mile apart. Near Coketon occurs a cross fracture of the rocks, whereby the southwest division of the Pratt coal area is dropped 160 to 180 feet below its former horizon; but the outcrop, having now suddenly become vertical, continues its former course 9 miles farther, making a total front line of about 16 miles. From the cross fracture below Coketon to the lower extremity of the field, the margin has been bent upward, and forms a vertical, subterranean rim, 180 feet in height—as measured from the level of the bottom of the basin to the outcrop at the surface of the ground. The Messrs. Woodward, of the Wheeling Furnace, sank a vertical shaft on the outcrop for 163 feet before reaching a point where the seam began to bend inwards. The coal was nearly 5 feet thick at the surface, but thinned on the descent to 18 inches; near the bottom it suddenly thickened again to over 6 feet, and at the same point veered inward at an angle of 50 degrees. As the seam and the roof were badly crushed at the angle, and the heading moved away from the shaft, mining became so dangerous that the proprietors wisely desisted from further operations; thus, unfortunately, leaving unsolved the question as to whether the margin is connected with the floor of the basin by a continuous curve, or whether in the drop of the rock mass it was snapped off and disconnected. After leaving this shaft the Messrs. Woodward moved inward on the basin, a few hundred feet, and sank two holes with the diamond drill, which reached the coal (lying apparently in a horizontal bed) at the depth of 180 feet. Some years ago a boring was made at Sulphur Spring Church, within 2 miles of Coketon, where the Pratt seam was reached at 140 feet. A boring made last summer quite near the Coketon shaft, and near the fault, showed a drop in the seam of 160 feet; the depth of the hole is considerably more than this, however, owing to the elevation of the ground at the surface.

In the neighborhood of Wheeling Furnace we find a marked change in the position of the Sub-Carboniferous rocks, which here lie along the east side of the front fault, in their natural instead of reversed order; and dip to the southeast at a gentle grade, say of 10 degrees. The whole series (limestones included) show lines of outcrop over a space of more than a mile in width, and of several miles in length; and finally butt against a ridge of lower Silurian chert on its eastern margin. Thus is revealed the presence of another fault, east of the Pratt fault, which may possibly be a continuation of the one seen 1,500 feet west of Boyle's Gap and at numerous other points—gradually approaching and perhaps cutting through Sand Mountain, and diagonally crossing the Silurian series of the Birmingham Valley. Following it south of Wheeling Furnace, this fault seems to cut off the chert ridge, and break into the dolomites.

Curiously enough, just at this junction of the Sub-Carboniferous series with the Silurian chert, and at the point where the chert ridge is cut off, there stands a huge fragment of Sand Mountain conglomerate on the top of the mountain limestone. This fragment is southeast of the direct line of the mountain, and was the only specimen of its kind that we saw for a distance of perhaps 5 or 6 miles; it is the site of a large quarry for furnace purposes. This dislocated region is familiarly known as "the burst-up."

The more eastern fault we did not pursue beyond the line of the chert ridge; but we saw indications of the western, or Pratt front fault, as far as Valley Creek, and for 2 or 3 miles beyond—keeping the same general course. Sand Mountain, which seems to have no representative in "the burst-up," except the fragmental bluff above mentioned, suddenly rises again a mile west of this bluff, on its old line, and trends away to the southwest under the name of Rock Mountain. The distance between the mountain here and the west fault just referred to is 2 or 3 miles; the intervening space is a syncline, on each margin of which run outcrops of the Newcastle and underlying coal rocks. In the Blue Creek region, on the west margin of this syncline, the lower seams are conveniently exposed. West of the fault the rocks dip gently toward the northwest, as they do farther north.

The sunken area of the Pratt seam does not appear to extend beyond "the burst-up," but terminates no doubt, as it begins, at a cross fracture. We did not trace this lower fracture, and hence cannot define the shape or size of the sunken tract. But, inasmuch as the strata on the high ridges immediately south of Village Creek seem to have resumed their normal relations, the indications are that the sunken area may not exceed two miles in width and nine miles in length. Whether the Pratt seam remains to some extent on the top of the high ridges just referred to, is a question we cannot answer, but we think it not improbable that such is the case. North of Village Creek the seam approaches, but does not reach, the Locust prong of the Warrior River. North of Five Mile Creek its outcrop curves away from the river in an easterly direction, and, lying in the high ridges about the sources of New Found Creek, joins the eastern outcrop at a point nearly west of Newcastle. The main body of this seam, above water level, lies on both sides of Five Mile Creek; the larger division being south of that stream. Its greatest width from east to west is about 10 miles, its extreme length 16 miles.

The synclinal basin in which the coal lies is irregular, not only in regard to the sunken area on the south, but also in regard to its slightly uplifted northern area; hence, in the part of the field lying north of Five Mile Creek, the dips are more nearly south than southeast. The uplifting of the north rim may have caused a cross fault which Prof. Smith observed a little north of Newcastle. Cross faults are not uncommon in this part of the field; but their drop is generally slight, and in most cases but little inconvenience results to the miner. Five Mile Creek cuts through the seam at its lowest line of depression. The distance from the creek, at the Milner mines, to the southeast outcrop is between one and two miles; the rise of the seam in that distance being about 200 feet, or at the rate of 100 feet to the mile. Going north, or a little west of north, from the creek the rise is about 50 feet to the mile, and the rate of ascent diminishes as we move westward. Going down the creek, from the Milner mines, the coal is found progressively higher on the hills, owing mainly, but not entirely, to the fall in the creek. This condition of things is highly favorable to economical mining, and points to the valley of Five Mile Creek as the great mining line of the future.

Allowing 1,000,000 tons of coal per square mile for every foot in thickness (which is but little more than the correct estimate), and supposing the Pratt seam to average 4 feet in thickness over an area of 100 square miles, the total store of coal in the seam is 400,000,000 tons. At the rate of 2,500 tons a day, more than 500 years would be required to exhaust the supply.

The demand for the Pratt coal, as already intimated, exceeds the present capacity of the mines, but the mining companies are constantly increasing their capacity. The yield of all the Alabama coal mines in November, 1882, and the prospective increase, are stated below by Dr. H. M. Caldwell, of Birmingham. From this statement it will be seen that of a present aggregate of 3,000 tons, the Pratt seam furnishes 2,300, or nearly four-fifths. It may be added that of the prospective increase, this seam will furnish a still larger proportion.

DAILY OUT-PUT OF COAL FROM ALL THE ALABAMA MINES.

(November, 1882.)

	Daily Tons.
Pratt Co., Pratt Mines	2,000
Milner Co., Five Mile Creek	300
Milner Co., Newcastle	200
I. T. Pierce, Warrior Station	100
M. I. Hoene, " "	75
Pratt Co., Helena,	125
Davis & Carr, Helena	50
Montevallo Co., Montevallo	100
Total out-put	3,000

PROSPECTIVE INCREASED DEMAND.

	Daily Tons.
By Sloss Furnace, No. 2	350
" Alice " No. 2	350
" Mary Pratt, Charcoal and Coke	50
" Woodward, "	350
" Wadsworth "	700
	1,800
By New Orleans:	
Steam	750
Morgan Line	200
Texas Railroad	250
	1,200
Total Prospective	3,000
Present Out-put	3,000
Total Daily Tons	6,000

Dr. Caldwell's estimate as to the future demand has reference only to what is now in view, and is moderate. Within a very few years after the Georgia Pacific Railway shall have crossed the Coosa, the Cahaba and Warrior Fields, the coal product will go far beyond any estimate that would seem at all reasonable at present.

III.—CLIMATE.

The belt of country which we have indicated as extending from Atlanta due west through Anniston, Birmingham, Columbus, Mississippi, Winona and Greenwood to Greenville, on the Mississippi River, is one of the most healthful and pleasant regions in the United States. The river and creek bottoms here, as on the Ohio, Delaware and James rivers, are subject to malaria at certain seasons; but care and quinine control malaria, and the people present a healthy appearance. One of us spent the entire summer (1882) in this belt of country, going without hesitation from hills to valleys.

We spent ten days, during the hottest period, on the Yazoo Delta—along the rivers, lakes and creeks—and worked on the Black Warrior during August. Except in June, the weather was perhaps cooler than usual; but we have certainly never experienced a more agreeable and invigorating summer temperature than that of this belt during the last season.

The most of the territory which we visited is cultivated by white people, and we did not observe any unusual disposition to avoid exposure to sun, rain or night air. The climate need repel no one, and should attract settlers in preference to that of the Northwest.

We present the subject more fully under the heads of Rainfall, Temperature and Health.

RAINFALL.

Vast areas of the western territory of the United States are almost rainless, and hence are uninhabitable except under an artificial system of irrigation which can reach only a small proportion of the surface. On this point really hinges the agricultural prosperity of every region.

In the vital matter of rain, the country we are considering is highly favored. Atlanta has 40 inches annually, which is the average of the Appalachian country throughout its length. From the Chattahoochee to near Columbus, Mississippi, the average is 44 inches; the Yazoo Delta has 48 inches; and the high country between the Yazoo and Tombigbee rivers has 60 inches.

Taking the line of country near the Northern chain of lakes, we find the figures 36, 32, 28 and 24 inches, before crossing the Mississippi; and west of that river, 20, 16, 12, 8 and 4 inches. What a contrast!

These significant figures tell of the present and of the future. The heavy wave of immigration must stop at the 97th meridian in the northern regions, with some additional scope to the southward. The rain gauge will guide the farmers of the future in the selection of new homes. Of necessity, the main stream of emigration must soon turn southward.

TEMPERATURE.

The average elevation of this belt is so great as to give it the climate normally belonging to sections lying from one to three degrees farther north. Atlanta, which is over 1,000 feet above tide level, is on the isothermal line of 56 degrees, which gives it the same average annual temperature as Washington City, Frankfort, Kentucky, and St. Louis, although these latter places have lower extremes in winter. The country between Atlanta and Byler's Ridge, west of the Black Warrior, is on this same isotherm. The western end of the belt has a temperature of two to four degrees higher. The climate of Atlanta and the mountain country of Alabama, taking it the year round, probably cannot be surpassed. In the Gulf States, in lower as well as in higher regions, the extremes of heat and cold are not so great as in the Northern States.

Contrary to the common impression, a man can do more out-door labor, in the course of the year, in the Southern than in the Northern States. The winters are mild, and in summer the thermometer has rarely been known to reach 100 degrees in any part of Alabama. The usual summer heat is from 78 degrees to 88 degrees. As to Mississippi, we have no statistics, but Major Wall, Commissioner of Agriculture, says of the temperature of that State: "The summers are long and warm, but rarely reach the extreme heat of the Northern and Northwestern States. The evenings and nights are pleasantly cool in consequence of the never-failing breezes from the Gulf. The winters are short and mild; ice seldom forms more than one inch thick in the extreme northern portion of the State, and in the southern part killing frosts rarely occur."

HEALTH.

We have examined the mortality tables of the U. S. Census for 1880, and find that as regards health Georgia, Alabama and Mississippi make a better showing than some of the oldest and most densely populated Northern States.

Annual death rate for each thousand of population.

New York	17.38
Pennsylvania	14.92
Virginia	16.32
Massachusetts	18.59
Kentucky	14.39
Georgia	13.97
Alabama	14.20
Mississippi	12.89

Here we have evidence of greater average longevity in each of these three Southern States than in any of the five other great States brought into comparison. And the showing would, no doubt, be more favorable if we could confine the comparison to the particular line of country we are now considering.

IV.—FORESTS.

The proportion of forest to cleared land in this region is large—being as three to one, at least. In every section along the line there is sufficient timber for local uses, and at intervals there are large virgin forests, comprising a great variety of trees.

THE PINE FORESTS.

The Pines are chiefly of three varieties, the Short Leaf (*Pinus Mitis*), the Loblolly (*Pinus Taeda*), and the Long Leaf (*Pinus Australis*). The Short Leaf is sometimes incorrectly called Spruce, and sometimes Yellow Pine. The Loblolly is also called Old Field Pine, and has a brush intermediate in length between the Short Leaf and Long Leaf. Its spines more nearly approach those of the Long Leaf, in point of length, but differ as to the shape of the bunches. The bunches, or brushes, of the Long Leaf are denser and somewhat egg-shaped, with the outer spines recurved, and grow on the ends of the branches only—giving the tree a comparatively naked appearance. A scant foliage is regarded by the lumbermen as indicative of a large heart, and this tree is nearly all heart. The Long Leaf Pine is probably the most valuable timber tree in the United States, on account of its great strength, which has been proved under pressure and strains of all sorts. It is also the most durable, owing to the resinous matter which permeates it. The demand for the lumber is very great. This tree is also the chief source of the tar, pitch and turpentine of commerce.

The Long Leaf Pine is scattered along the whole route from Atlanta to the Yazoo Delta; but there are five distinct forests of it, of which three are so large as to be represented, though not with entire accuracy, on the forestry maps of the last United States Census. One of these forests is bisected by the State line of Georgia and Alabama, and lies in the counties of Polk, Haralson, Cleburne and Cherokee. The Georgia Pacific Railway runs through the southern part, where it has scarcely been touched by the axe. The timber shades into a miscellaneous growth in Cleburne Co., but the Long Leaf Pines continue in liberal proportion all the way to Blue Mountain.

The second large forest of this pine lies on both sides of the Coosa River, but the greater portion is on the west side, beginning with the chert ridges and extending into the Coosa Coal Field. There are other bodies of this timber in Cahaba Valley, between Birmingham and the Warrior River. The third forest is west of the Warrior River, but only its south point, near Democrat, will be touched by the Georgia Pacific Railway, although a large proportion of it will be available. Sawmills are in active operation at several points in the several forests above indicated.

Next in value is the Short Leaf Pine, which has a larger proportion of sapwood than the Long Leaf, but makes excellent lumber, and is well known as the Yellow Pine in sections north of the Long Leaf region. The Short Leaf is a larger, though not taller tree, and is copiously intermingled with other trees almost everywhere in the belt. It prefers clay soils, but forms a separate forest only in Fayette and Lamar counties, Alabama, where, in association with the Loblolly, it occupies an area whose shorter diameter is over twenty miles.

The Loblolly is as remarkable for its large proportion of sapwood as the Long Leaf for its large proportion of heart; for inside finishings, boxes, etc., its value will steadily increase.

DECIDUOUS FORESTS.

Whilst the sandy lands incline to Pine, the clays and clay loams produce a miscellaneous growth of hard woods, varying in size with their position and with the porosity of the sub-soil. The red lands produce the same varieties as the gray, but of larger size; whilst the coves and valleys are heavily timbered with moisture-loving trees. On all the formations the Oaks predominate among the deciduous trees, and are in great variety. The White, Black, Red, Spanish, Chestnut (or Rock), Water, Willow, Black Jack, Post and Overcup Oaks all abound, and gain in size as we go west. The smaller sizes are possibly harder and more durable, because, like the Long Leaf Pine, they have grown slowly. For railroad ties, fence posts, piles, telegraph poles, &c., they will be preferred. The Post Oaks and Black Jacks are naturally small, but grow to a large size on much of the Mississippi territory, especially the Post Oak, which will no doubt make good bridge timber. The White Oak timber also gains in quantity and size as we go westward. It seemed to us that the best wagon and ship timber we saw was in the hollows and on the richer horizons of the Warrior Coal Field.

The Black Oak is abundant everywhere; the Red and Spanish Oaks are in unusually large proportion, and of fine size; and the Chestnut Oak abounds on the ridges west of the Coosa. The presence of these trees points to great tanneries to be operated in connection with a large trade in cooper stuff, square timber, charcoal and quercitron. The great oaks and other timber of the Yazoo Delta will be mentioned specially.

We were also struck with the large proportion of Hickories that are everywhere found. They are chiefly of the smooth bark varieties, though not exclusively so. The value of this timber for all purposes requiring toughness and elasticity, and its comparative rarity, renders its presence a matter of some importance.

We observed some Ash and Elm, and a considerable growth of the Tulip Poplar. The latter makes the best of weather-boarding, and the white variety has an ornamental white wood. The Sweet Gum is common, but that which grows on dry uplands is not esteemed for lumber, owing to excess of sap wood; on moist bottoms, however, and notably in the Yazoo Delta, the heart enlarges greatly, and its fine grain and beautiful red color, resembling that of the Red Cedar, make it then valuable as an ornamental wood. We saw it in the panels of a Pullman car; and when the immense trunks growing in the Yazoo Delta become available, this wood will be greatly sought for cabinet purposes.

Linn, Honey Locust, Wild Cherry, Red Maple and Sugar Maple are seen occasionally. The Black Gum is common; the Chestnut rare. The Willow Oak and Water Oak are abundant, and the most beautiful of trees. The Cottonwood fringes the banks of the Mississippi River, but is seldom seen elsewhere on this line. The Sumac is abundant everywhere, and will immediately become an article of commerce. We observed two varieties; the smaller of which contains the most tannin, and abounds as undergrowth—particularly in the Long Leaf Pine forests. The Sipsey, Buttahatchie and Luxipolila lowlands are heavily timbered—the prevailing growth being Beech, Tulip, Sweet Gum, Black Gum, and Shellbark and other Hickories. As we approach the Tombigbee, the Cypress, Tupelo, Hackberry and Ash come in.

There is a hommock country skirting the Tombigbee on the east, and exceptionally on the west, which is timbered with the upland Oaks and Hickories. The western margin of the Tombigbee River, in its upper reaches, consists usually of Black Jack and Post Oak ridges, belonging to the Tombigbee Sand Group. These, however, soon pass into the beautiful prairie country, which is timbered only in patches and occupies the western half of Lowndes, and the eastern half of Oktibbeha counties. West of Starkeville, in Oktibbeha Co., lie the Flatwoods, a belt which has a heavy, wet, clay soil, and is given up to the Oaks and Short Leaf Pine. Almost the whole of Oktibbeha County is flat or very gently undulating, and, although the change of soil and timber is very noticeable at the line of junction between the Cretaceous Prairie region and the Tertiary Flatwoods, yet it is not so easy to recognize Dr. Hilgard's delineation of the Flatwoods belt. Veering a little to the south of west, in order to visit certain beds of lignite, we passed from Starkeville to Whitefield (17 miles) and thus crossed the Flatwoods somewhat diagonally. We were agreeably surprised at the quality of the soil and the size of the timber along our route. The timber is large, and the soil apparently only requires drainage to make it good grass land: but more is said upon this subject in discussing soils. We travelled in the Flatwoods region proper about seven miles, and then on a yellowish flat for seven miles farther. The latter stretch is more open, but has much good timber on it.

Crossing Sand Creek at Whitefield we passed at once into an elevated region which continues to and beyond Chester, the county seat of Choctaw. This elevated, sandy, and in places clayey region, between Sand Creek and the Big Black River, has a miscellaneous growth of timber of average size, with occasional areas of large trees. The timber found on the flats of the Big Black is large, and consists of Beech, Hickory, Ash, Elm, Hornbeam, Red Bud, Sweet Gum, Swamp Chestnut Oak, Tulip, Turkey Oak, etc.

From the Big Black valley, through Sumner Co., and part of Montgomery Co., to Winona, the upland forests improved as we went westward, and we noted numerous fine groves of Oak and Hickory. Advancing through the west side of Montgomery, and through Carroll Co., toward the Yazoo Delta, the timber improved with the soil. The numerous large forests of Carroll deserve especial mention ; the Oak prevails, and is often imposing in size and shape. The Post Oak and Black Jack, which are usually inclined to be scrubby, are here of good size. The Pine, Walnut, Chestnut, Tulip Poplar etc., are also abundant.

But the great forests of the route—in respect to the size and burden of the timber—are found on the Yazoo Delta.

Le Flore Co. begins at the Bluffs and lies wholly within the Delta, along the margin of which runs the line between Le Flore and Carroll counties. As the "Scatters," or torrents which the rains send from the hills to bespread themselves over the plain, bring down upland soils and seeds, we accordingly find upland trees near the bluff; and the earth of the bluff formation being highly calcareous, wherever it is found in the Delta there are also found lime-loving trees, such as the Tulip Poplar, Linn, White Oak, Post Oak, and remarkably large specimens of the Sassafras. Farther inward on the Delta, however, these give way to the Overcup Oak, the Swamp Chestnut Oak, the Pecan, Shellbark Hickory, Red Sweet Gum, Tupelo, Cypress, Willow Oak, Water Oak, Elm, Ash, Holly, Hackberry, Turkey Oak, Beech, Honey Locust, White and Red Maple, some Walnut and, on the western edge, Cottonwood.

Inasmuch as this great plain—which extends from Vicksburg to Memphis, and from Greenville, on the Mississippi River, to the bluffs on the edge of Carroll Co., thus embracing more than ten large counties—is destined to become as famous for its timber as for its soil and agricultural productions, we desire to give some clear idea of the enormous natural growth upon it.

Probably not one-fourth of the plain is cleared; and the other three-fourths, perhaps four-fifths, is covered with probably the heaviest forest on the American Continent. We have seen forests where the trees were more crowded, and were feeble and attenuated in consequence; but here the trees usually have room for the full development of their trunks at least. The foliage is high overhead, whilst the great trunks seem sound and healthy, and stand in endless and impressive columns around the traveler. Occasionally we found too much crowding, and hence smaller trees—constituting areas of what would be called simply good timber—but the mills which attack these forests must always be supplied with the double saw arrangement, when circular saws are used, many of the logs being much too large to be cut by a single saw.

At present, the few saw-mills that are at work confine themselves chiefly to the Cypress, which in this region is the substitute for Pine, and brings the highest price. The Cypress, Red Sweet Gum, Tupelo, Swamp Chestnut Oak, etc., grow in or near to bayous or drains, and may be floated to the mills in seasons of high water. The light and heavy timbers are rafted together, so that they may be floated in shallow water.

The Tupelo (*Nyssa Uniflora*) has much greater value than is usually ascribed to it. It is soft when green, and very hard when dry. It also when dry combines lightness and toughness to a remarkable degree. Its value is already recognized in the manufacture of trays, bowls and other domestic utensils; but its use will extend to the making of many kinds of implements and vehicles in which lightness and firmness are of more importance than great strength, as, for example, in hoe handles, carriage bodies, boxes, &c., &c. It is also suited for flooring and other inside work in houses. At Seppardtown, on the Yazoo, we saw a beautiful counter in the store of Maj. W. H. Morgan, made of the Tupelo wood. It is nearly white, and seemed to be free from scratches and cracks, as well as from knots.

We here repeat that the Sweet Gum of the lakes, sloughs and bayous is greatly undervalued on account of the indifferent character of the upland Sweet Gum, which is chiefly sapwood. But on the wet lands the proportion of heartwood becomes very large, and is of an agreeable reddish tint—resembling that of the Red Cedar. This timber also is soft and easily worked when green, and becomes hard and light when dry. It is said to be very durable. It will undoubtedly be much used in cabinet and other ornamental work, and in the interior finish of railroad passenger cars.

The Cypress, Tupelo and Sweet Gum are all first-class trees as to size—a diameter of four to six feet being common. But there are other trees not inferior to these in size, among which is the Swamp Chestnut Oak, or Swamp White Oak (locally called the Cow Oak), the wood of which resembles that of the White Oak, but is less tough and compact, though very valuable.

The Willow Oak and the Water Oak grow well on uplands and make the finest shade and ornamental trees, as may be seen in the streets of Tuscaloosa, Alabama, and at many other places. But to see the Willow Oak and Water Oak in their full glory one must go to the Yazoo Delta.

Besides the larger trees, all of which we cannot describe in detail, the smaller ones, such as the Holly, Persimmon, Sassafras and Hornbeam, grow in the Delta to an unusual size. We saw a grove of Hollies on Blue Lake, the larger sizes of which averaged about fifteen inches in diameter; and Mr. J. Y. McNeil, at whose house we saw this remarkable grove, told us of another and larger grove near by, many trees in which measured two feet in diameter. Sassafras trees two and a half feet in diameter are reported.

A volume would be required to portray fully the wealth of timber which burdens this vast alluvial plain. The area of the Delta is calculated to be about 4,000,000 acres, and it is safe to say that 3,000,000 of these are in original forest. It is worthy of note that nearly all of this timber may be brought to the line of the Georgia Pacific Railway by river transportation. This results from the fact that all the streams of the Delta run from north to south, whilst the railway crosses it from east to west. Such access to the timber, as well as to the agricultural products of this region, could not be enjoyed by any north and south road, and the crookedness of the streams only adds to their convenience and extent as transportation routes.

The Yallabusha, Tallahatchie and Coldwater rivers drain the northeastern quarter of the Delta, and unite their waters before reaching Greenwood, where they cross the line of the railway. Regarded from this point, and considering only so much of these streams as run in or near the Delta, we find on the Yallabusha a practicable water route for timber of about 120 miles, northeast to Grenada; on the Tallahatchie, 225 miles, to Batesville; on the Coldwater, 275 miles, to the Yazoo Pass; and on the numerous creeks and bayous (available at ordinary high water) probably 600 miles more. Of course, near the upper ends of these streams much of the timber would take other directions, but the great body of this region is most convenient to the Georgia Pacific Railway. The Yazoo and Sunflower Rivers, with their tributaries, drain the entire Delta.

South of Greenwood there is regular steamboat navigation, by means of which floating as well as stationary saw-mills can conveniently supply any amount of lumber.

The Sunflower River is also navigable for steamboats, in flush water, up to the railway crossing at Johnsonville, in Sunflower County. This river, Bogue Philia, Deer Creek and Black Bayou, all furnish practicable channels for lumber, at certain seasons, amounting to many hundreds of miles in length.

V.—SOILS.

Inasmuch as the Georgia Pacific Railway crosses the entire geologic series, we naturally expect to find every variety of soil along its line. As already indicated in our geologic sketch, we have at the eastern end of the belt a continuation of the Archæan (or, more properly, the Metamorphic) region, which extends along the Atlantic slope of the American Continent as far south as the Coosa River, at Wetumpka, Ala. Its eastern border is the head of tide water, and is marked by the granite mass which shows itself near Trenton, Philadelphia, Baltimore, Washington, Richmond, Weldon, Columbus, Ga., and Wetumpka, Ala., and occasions the lower falls of the eastern rivers. Its western line is the axis of the Blue Ridge Mountain, which may be roughly indicated south of New York by Easton, Reading, Harper's Ferry, the Peaks of Otter, the western boundary line of Tennessee, the Dug-down Mountain, in Georgia, and its Alabama continuation, Blue Mountain.

In Alabama we also find Silurian and Carboniferous soils, which lie west of this great Archæan belt; and in the western part of this State, and in Mississippi, we find soils based on the Cretaceous, Tertiary, Quaternary and Alluvial formations, such as characterize the great tide-water plain that forms the Atlantic seaboard from New Jersey to the Mississippi River, and beyond.

As the surface wealth of an agricultural country is not less important to a railroad than is its underground wealth, and as the soils above tide water have been formed by the disintegration of the rocks underlying them, with such local exceptions as creek and river bottoms, the wash from hills, etc., we will base our descriptions upon the geology of the country as already defined.

The highest axis crossed by the Railway is the Blue Mountain in Alabama, near the west base of which runs the Selma, Rome & Dalton

Railroad. This mountain marks the division between the Archæan and the Silurian soils. Hence the soils of all the country from Atlanta to the west foot of the Blue Mountain—say sixty-five miles—are Archæan or Metamorphic. From this line to the west rim of the Birmingham Valley, except as to the narrow Coosa and Cahaba coal fields, the soils are Silurian. From the Birmingham Valley to the Sipsey Fork of the Tombigbee, which is the western edge of the Warrior Coal Field, the soils are formed from the Carboniferous rocks. From this line to the Mississippi River the soils are made up of transported matter belonging to the Cretaceous, Tertiary, Quaternary and Recent periods.

ARCHÆAN SOILS.

Any one who has traveled over the Midland and Piedmont sections of the Atlantic States is acquainted with the appearance and general character of the surface from Atlanta to the Blue Mountain. There are reddish brown, chocolate brown, dark gray, light gray, and whitish soils; and, in quality, good, bad and indifferent. These lands have usually been cultivated on what Liebig calls "the spoliation system," and its results are manifest.

The best counties of Pennsylvania, namely, Adams, York, Lancaster, Chester, Delaware, Philadelphia, and parts of Berks, Montgomery and Bucks, are on this Archæan formation, mainly. So, also, are half a dozen of the best counties in Maryland, a dozen in Virginia, and a number in North Carolina. The Archæan soils, however, vary greatly, as will now be shown.

SANDY SOILS.

The lowest grade of these soils is formed from the wear of quartz rocks, with but little admixture of plant food. On them are found the forests of Pine, whose tap roots go deep. A sandy body, with some admixture of other necessary elements, makes the best corn and pea land; and cotton, which makes but a poor show at first on sandy land, is often found to yield well. These are the soils for underground crops, which become more important with the increase of towns, factories and railroads. Of all varieties they are most cheaply cultivated, and hence profits are made on small crops, such as would ruin a clay-land farmer. On sandy, micaceous and granitic soils, one horse, mule or ox usually suffices for the ploughing, and the harrowing is often omitted; deeper ploughing would, of course, produce better results.

Fruits often succeed well on these soils, and, when underlaid by a somewhat retentive sub-soil, the lands improve rapidly under a lime and pea system of fertilization. With a proper proportion of clay and other elements, these are the most productive of all lands. There are strata of Archæan sandstone, charged with iron and calcareous matter, which break down into soils of superior quality.

MICACEOUS SOILS.

These are the next grade above the poorer qualities of sandy land. They are light gray in color, loose in texture, and best suited to corn and cotton. When formed from the disintegration of *Muscovite*, or common mica, their chemical composition is such as to require an artificial supply of lime and phosphoric acid to give them the necessary mineral basis for large crops. Other varieties of mica produce a much better quality of soil. But phosphoric acid and ammonia must be added to all micaceous lands in order to make them satisfactory. In Virginia, this sort of soil and the one to be next mentioned are much used for tobacco, and sometimes produce an article which although small and light may command a better price than the heavier grades.

GRANITIC SOILS.

Included under this head are the gray soils formed from true gneiss and granite. These have usually a large proportion of potash, and are nearly always in good mechanical order. They contain a little mica, but have feldspar, also; and hence often disintegrate rapidly—an important consideration in keeping up the productiveness of a soil. These are corn, tobacco and cotton lands, but, although better than the micaceous lands, they need the same treatment.

THE HORNBLENDIC SOILS.

These red or brown (iron stained) lands, as a rule, are naturally fertile, and are the richest of the Archæan soils. Their parent rocks contain hornblende or epidote—usually the former—which secures a good proportion of all the mineral elements of fertility. In fact, the decaying rocks themselves are often a good manure. These soils have a large development in the region near the mountains, and for the cereals, grasses and mixed husbandry are first quality lands. The Census tables show that some of its belts surpass in grain production the best soils of the Great Valley. Like all other lands, they can be destroyed by bad farming. If the practice is "all off and nothing on;" three-inch ploughing on hillsides; no horizontal ditches; no sod, clover or manure; no stopping of gullies—nothing, in short, but reckless spoliation year after year, and generation after generation—what lands could endure such treatment? But, in spite of a melancholy proportion of such farming, there are large tracts of this country that are still rich, and some that are well farmed; and all are reclaimable.

GENERAL REMARKS ON THE ARCHÆAN SOILS.

The Southern planters usually divide these soils into only two classes—red and gray; and, because they prefer corn and cotton to wheat and grass, they also prefer the gray lands to the red. They claim that the gray lands are sooner in order for planting in the spring, and are much surer to mature all the cotton-bolls in the fall. Hence they get more cotton than from the richer soil, and the culture is cheaper. The gray lands are in larger proportion than the red.

So far as we know, there has been no systematic effort made to introduce grape culture into this region, and yet the grape is reported as growing well everywhere. It has been demonstrated in Virginia that the Piedmont soils are well suited to grape culture. The indications are that this Piedmont belt is the best fruit region of the continent. Certainly, in respect to apples and peaches, it cannot be surpassed, if equalled. Queen Victoria and her Court were so well pleased with the flavor of the Albemarle (Virginia) Pippin, grown on Archæan soils, that Parliament forty years ago passed an act admitting Albemarle Pippins into England free of duty. It seems, from the statements of Dr. Jones, of Georgia, that the fruits of the Archæan cotton region have the finest flavor, but the trees are not equal to those grown on the higher lands. A. J. Downing, in his "Fruits and Fruit Trees of America," says: "Some of the new Southern winter apples are of surpassing quality, caused, doubtless, by the more complete elaboration of their juices during their warm and lengthened season." Similar remarks might, no doubt, be made concerning the peach, which, by all accounts, flourishes well, and is now made an early shipping crop, as we observed this season.

Upland rice follows cotton, and the cotton line has been carried fifty miles into the upper country by the use of fertilizers.

In the sequel we shall call attention to the neglected fact that this, as well as the belt generally, may be made a good grass and live-stock region.

SILURIAN SOILS.

These are the most noted of all soils, because, in their more important belts, they are calcareous clays especially adapted to grass and wheat, whilst producing well nearly all the crops suited to the climate, including cotton in this belt. This is the great valley formation which extends from the Coosa River to the Delaware. Its lands are not all of the first quality. The Potsdam and Calciferous series, which lie at the base of the Silurian, are made up of sandy and heavy clay soils; some of them are colored by oxide of iron and are productive, but they are generally deficient in some elements—perhaps in potassa salts and phosphoric acid. These rocks generally form the high ridges which are valued for timber and as cattle ranges.

But the Quebec and Trenton limestones, and accompanying shales, furnish the soils which have made this geologic belt famous from Alabama to New York. The lands of Bibb, Shelby, Talladega, Jefferson, Calhoun and Cherokee counties, in Alabama, long exhibited their ability to produce large crops, and, we may add, to bear hard usage, though compelled at last to succumb so far as to mask their true character. The chert ridges, whose soil is inferior, occupy more space in this region than they do farther north.

CARBONIFEROUS SOILS.

There are no Devonian soils worthy of notice in this region. Those of the Sub-Carboniferous formation run in narrow strips, flanking the Silurian valleys from the Coosa westward. The mountain limestone makes a fertile soil, but has only a slight development in this belt. The silicious limestone, near the base of the series, is always present, and, as heretofore stated, disintegrates into a red and fertile soil.

The Carboniferous soils are formed most frequently from the shales, and from the softer and more argillaceous sandstones. Hence clay soils preponderate. These soils are not rated high, but their character is better than their reputation. We saw in many fields cotton crops of a bale, and corn crops of forty bushels, to the acre. These were fresh lands on the better horizons. The Curry plateaux are too sandy, and form the most indifferent soils of the coal series. The creek and river bottoms are narrow and fertile, and are better suited to corn than to cotton. The season on the bottoms being shorter, and the soil rich and moist, the cotton plant makes too much "weed" for full fruitage, and is caught by frost before the maturity of the upper bolls.

The people who cultivate the soils of this region are generally without surplus means, and have no system of farming except to clear, wear out and turn out the land, which limits the life of an upland field to six or ten years. When the price of cotton is high, the crop is nearly all cotton, and corn and bacon have then to be purchased. When bacon also brings a good price, the crop is corn, hogs and cotton. A constant war of extermination is waged on grass. The land is finely adapted to potatoes of both kinds, to beans and turnips, and to vegetables generally. All the common fruits, including figs, come to perfection on the Warrior rivers. The woods furnish good range.

Outside the bottoms, these lands lie chiefly on wide terraces or benches, on wide, flat-topped ridges, and in pleasant coves. They are easy and pleasant to cultivate, and of late years, when turned out after having been robbed, the Lespedeza, or "wild clover" as it is here called, covers the fields and gives support to an annually increasing number of cattle. Owing to the drought of 1881, the crop of 1882 could not have been raised but for the old fields, where the mules were pastured on the Lespedeza after each day's work. In this fact we have the key of the future. Grass will convert this into a sheep, goat and cattle region, and keep up the fertility of the lands. Hogs live in the woods, with but little corn at any time, and in a good mast year like the last they need none except the little that is fed to the porkers to give firmness to their flesh. Fowls are healthy and require but little feeding.

CRETACEOUS SOILS.

West of the Warrior Coal Field, toward the border of the State, we reach a remarkable group of soils belonging to the Cretaceous period, The Cretaceous belt is, say, 60 miles wide on the parallel of

Columbus, Mississippi, and lies about equally in the two States. We call this whole region Cretaceous, although a considerable proportion of the surface is composed of drift material belonging to a later period. There are four zones of soil in this formation, corresponding with its four geological subdivisions.

The east zone consists of a yellow clay mixed with sand. This soil is not naturally productive, but, as it has a good body and most of the requisite elements, it is easily improved. The second strip is sandy, but calcareous. These two strips lie chiefly in Alabama, but are found also in the eastern parts of Monroe and Lowndes counties in Mississippi. The main ridge between the Tombigbee and Buttahatchie rivers is a high flat of mellow soil. The bottom lands of the Sipsey and Buttahatchie rivers are wide, and heavily timbered, and have a light, fertile soil. The Tombigbee "hommock" lands, or lands intermediate between the bottoms and the hills, are generally fertile, though sandy and gravelly near Columbus, and are easily cultivated. In Lowndes Co., there are wide, fertile river bottoms, and in some sections, as about Aberdeen, the hill lands are good, though not generally so in this belt.

Moving west, into Mississippi, we come next to the famous "prairie region," which lies in a string of irregular areas in Kemper, Noxubee, Lowndes, Oktibbeha, Clay, Monroe and Chickasaw counties—their combined area, according to Prof. Harper, amounting to nearly 150,000 square miles. There are areas of it, also, in Marengo and other counties in Alabama. The prairie lands are level, or gently undulating, with dark, heavy, calcareous soils that are often simply clay marls or rotten limestone. These prairies are in some places exceedingly rich, but are not always productive—owing sometimes to hard usage, but often to their mechanical condition, which calls for a loosening treatment. A farmer near Okalona is said to have sub-soiled one half of a field, and to have ploughed the other half in the usual shallow way, before plainting in corn; the result being 40 bushels to the acre on the sub-soiled half, and 20 bushels on the other. The whole prairie country is based on a white, chalky limestone, which shows in patches, and occasionally on the streams in mural cliffs. Along the Tombigbee River, in sight of the railroad, it reminds one of the Dover Cliffs on the English Channel. The patches of rotten limestone cropping out in the fields annoy the farmer, but it has been proved by experiment that with a dressing of rough vegetable matter these spots will grow clover, and ultimately sod over.

A more beautiful and desirable country than is this prairie region, or one more surely destined to celebrity, is not to be seen anywhere. It is adapted to all crops. The Georgia Pacific Railway will traverse it from the handsome and dignified little city of Columbus to the thriving village of Starkeville—a distance of 26 miles. The Agricultural College, near Starkeville, under Gen. Stephen F. Lee, is doing good experimental work in this section. The prairie lands are rated at from 12 to 20 dollars per acre—cheap enough, surely.

TERTIARY SOILS.

Three miles west of Starkeville we leave the Cretaceous formation and enter the Tertiary, which occupies about two-thirds of the State of Mississippi, but is largely covered by drift. On passing from the Cretaceous we first find a strip of level, soggy land, from 3 to 6 miles—and sometimes from 10 to 12 miles—in width, which runs nearly north and south through the east side of Chickasaw, Calhoun, Choctaw, Oktibbeha, Winston, Noxubee and Kemper counties. It is called the Flatwoods, and was described to some extent under the head of Forests. The soil is chiefly of light yellow clay, and is deficient in lime (the reverse of the prairie soil). It has been considered as suitable for timber only, but the clearings are encroaching upon its borders and are giving better results than were anticipated. Lime and drainage will convert this soil into good grass land.

Beyond the Flatwoods we find a good agricultural country all the way to Whitefield (17 miles from Starkeville), and yet its soil, to the eye, differs from the Flatwoods soil only in being dryer, and hence warmer in its tint. Passing the border of these flats we suddenly climb the low range of hills which constitute the watershed between the waters of the Tombigbee and Mississippi rivers.

This is the *Lignite region.* At Whitefield we found S. D. Morse, a blacksmith, who used lignite, whenever he could get it, in preference to charcoal. He said there was a six-foot bed of lignite on Mrs. Collins' land, 3 miles distant, which makes a stronger heat than charcoal. For 20 to 30 miles along this line lignite beds exist, but, though their basset edges may sometimes be seen, there is no clear opening to be found. Besides smut on the road side, we saw something of the outcrop in three places; two near Chester, the county seat of Choctaw, and one at Jesse Fulcher's, between Chester and Whitefield. It is said that the best bed is on the land of Pressly Oswalt. Adams and Quin are also reported to have beds of it on their lands.

Iron Ore is associated here with the lignites, as is the case in Vermont. The fossils, as interpreted by Lesquereux, show that the Mississippi Lignite beds are contemporaneous with those of the Rocky Mountains and the Upper Missouri country. Along the Pacific Railroad, in the Rocky Mountains, lignite is used in the locomotives; but true mineral coal, from the same formation, is sometimes used under the name of lignite. In every case it is only a question as to how far the carbonizing process has gone, in order to determine whether we are dealing with peat, lignite, bituminous coal, or anthracite. During the excavation of the Dutch Gap Canal below Richmond, Va., a fossil tree was discovered lying prostrate, and exhibiting in its trunk and limbs nearly all the stages of carbonization; and also, near the butt, complete silicification. Hence, in respect to the lignites of Mississippi, no estimate of their commercial value can be made without far more exploration than has yet been attempted.

Returning from this digression, we remark that the hill country between the Flatwoods and the Big Black River (25 miles) is generally sandy and unproductive. On the Big Black we find rich, though narrow and low-lying bottoms. From the Big Black to Winona (18 miles) the hills are not so elevated as on the "divide," but they are 50 to 100 feet above the streams, and the soils are good or bad according to the presence or absence of the Quaternary Yellow Loam. In the old fields we found Lespedeza, but no Bermuda Grass, between the Prairie and the line of the New Orleans and Memphis Railroad. This railroad is said to have introduced the Bermuda for the protection of its own embankments, and certainly no better sheeting could be obtained.

The Yellow Loam is Quaternary, and makes the finest upland soil in Mississippi. Prof. Hilgard calls all the country from the Flatwoods to the Yazoo Delta, Yellow Loam, but it prevails most decidedly in Montgomery and Carroll counties, and but a few years of good farming are required to make these counties a delightful agricultural region, in all respects. They are high and healthy, with fine timber; the soil, which is drained by a sandy sub-soil, inclines to grass, but is friable and good for corn. The loam deepens as we approach "the bluff," or the great escarpment which marks the old shore line of the Father of Waters—now 75 miles distant. Fruit trees, as well as forest trees, grow extra large in this loam, and in places the corn was very fine. Post Oaks, and even Black Jacks, become large trees in this soil; and, though in many spots it thins to nothing, it is said to average three feet throughout the Yellow Loam area. But we must pass to the final grand division of Mississippi soils.

THE ALLUVIAL SOIL OF THE YAZOO DELTA.

The term Mississippi Bottom properly belongs to the entire plain between the bluffs within which the Mississippi River runs, beginning at The Chains, thirty miles above the mouth of the Ohio, and extending to the Gulf of Mexico. The Yazoo Delta is the part of this plain lying between Memphis and Vicksburg, and is properly so named from the fact that the Yazoo River with its tributaries drains the whole of it. This vast delta is ellipsoidal in shape; its length is 180 miles, and its greatest width 75 miles. Its area is over 7,000 square miles by Prof. Harper's computation, and nearly all of it is in Mississippi. It is crossed by the Georgia Pacific Railway near the line of its greatest width. Much of the delta is liable to inundation, and on this account was long avoided by planters. But, thirty years ago, the Mississippi River—which had communicated with the delta through the Yazoo Pass and other bayous—was excluded by levees, and, except where broken lately, these are now continuous from the mouth of the Yazoo River, near the southern extremity of the delta, to its northern extremity near Memphis. Were the levees made secure, or the jetty system of deepening the channel resorted to, as probably will be the case, the delta generally would be protected from inundation; and local levees would protect and dry off much of the interior now subject to overflow. Congress has taken the matter in hand with an energy which promises the best results.

All the soil reached by the plough is of two classes—loam and clay. The loam lies in ridges, 5 or 6 feet high, along the banks of the streams from whose over-sloppings it was deposited. The clay underlies the loam throughout the delta, and is reached between the loam ridges where the surface has received less deposit. When swamps occur they are equi-distant between the loam ridges. These loam belts act as levees, and because of their dry and elevated character are preferred for building sites. They are not confined to the banks of the existing streams, however, but are often found curving about in the plain—indicating where streams once ran, and not infrequently enclosing crescent shaped lakes which rest in the bends of the departed rivers. The loam varies, being sometimes light colored and over sandy, but is generally dark and rich. The dark loams are easy to work, quick, nearly always in good mechanical condition, and when summer rains are seasonable produce the largest crops. The clay lands are called "buckshot lands," because the soil dries into angular bits the size of buckshot. This soil is lead-colored, and when wet has the feel of soft soap—being soft, smooth and slippery. To look at this soil when wet, one would think it unpromising for agriculture; but when dry it falls to pieces, becomes loose and light, and, taking one year with another, constitutes the most productive land. Prof. Hilgard ascribes the fertility of these soils mainly to certain ferruginous concretions which they contain; but to the eye they seem to be composed of finely comminuted clay, intimately compounded with carbonaceous slime. The planters get about one bale of cotton, or 35 bushels of corn, to the acre; but we doubt not that if they would plough eight inches, instead of three, and keep their crops clean, the average of the buckshot and black loam lands would be two bales of cotton, or fifty bushels of corn.

The Blue Grass region of Kentucky will not be able to surpass the buckshot lands in the production of grass when the war waged upon it here by the planters shall have ceased. The streets of Greenville, on the Mississippi River, show as close a sod as can be seen on the Elkhorn in Kentucky. A planter, not far from Greenville, sowed grass on his land, and a neighbor sued out an injunction against him. Fortunately, when the case came to trial, the court decided that grass on a neighbor's farm was an affliction that had to be borne.

Cattle and hogs thrive on the Delta almost without being fed. The wild grasses in summer, and the switch cane in winter, keep the cattle in good order; whilst roots, acorns, beech-nuts, pecan nuts, &c., furnish abundant supplies of food for hogs. The whole delta is burdened with animal and vegetable life, and nothing short of a volume can describe its wealth and all its attractions.

This region has a most unmerited reputation for ill health. Unquestionably, malaria abounds in September, but it is manageable and the people are manifestly healthy. Having been there during the hottest spell of last summer, we would not now fear to return to it at any time. The timbered lands can be bought at from $1 to $5 an acre, and the improved lands at from $5 to $30 an acre. If there is any better investment in the world we know not where it is.

The Mississippi Bottom, which once reached to the mouth of the

Ohio River, has justly been compared to the delta of the Nile; but we are in the habit of regarding as an evil, what the Egyptians regard as their greatest blessing, viz., inundations. The great Mississippi plain can be, and will be, protected against floods; and yet floods made it what it is, and would build it higher and maintain its fertility. As long as it remains insufficiently protected, however, planters must be prepared for freshets. Since the drainage of the Yazoo Delta has been improved, the cotton planters have been clearing away the forests and substituting crops of corn and cotton, but the development of this kingdom of agricultural wealth has scarcely commenced. The delta of the Nile has never approached in productiveness that of the Yazoo River.

VI.—POPULATION, PRODUCTIONS, ETC.

COMPARATIVE STATISTICS.

Georgia, Alabama and Mississippi are first-class States in point of size and resources. Their areas and population are compared with those of other States in the two following tables:

	Square Miles.
New York	49,170
Pennsylvania	45,215
Virginia	42,450
Massachusetts	8,315
Kentucky	40,400
Georgia	59,475
Alabama	52,250
Mississippi	46,810

Population of	1870.	1880.	Per cent. of Increase.
New York	4,382,759	5,082,871	15
Pennsylvania	3,521,951	4,282,891	21
Virginia	1,225,163	1,512,565	23
Massachusetts	1,457.351	1,783,085	22
Kentucky	1,321,011	1,648,690	24
Georgia	1,184,109	1,542,180	30
Alabama	996.992	1,262,505	26
Mississippi	827,922	1,131,597	36

Here we see that the ratio of gain in population is greater in the three Southern States than in the five other leading States named; and a like result would be obtained from comparison with other States. And this *ratio of gain will increase hereafter.*

Let us try another test, namely, the multiplication of farms:

TOTAL NUMBER OF FARMS.

	1870.	1880.	Per Cent. of Increase.
New York	216,253	241,058	11
Pennsylvania	174,041	213,542	23
Virginia	73,849	118,517	51
Massachusetts	26,500	38,406	45
Kentucky	118,422	166 453	40
Georgia	69,956	138,626	97
Alabama	67,382	135,864	101
Mississippi	68,023	101,772	40

Here, again, the ratio of increase is greatest in the three Southern States.

The gain in the production of *Cereals* is also striking:

BUSHELS OF GRAIN.

	1870.	1880.	Per Cent. Increase.
New York	77,761,688	89,926,704	15
Pennsylvania	97,492,934	106,840,422	9
Virginia	32,540,244	42,737,004	31
Massachusetts	1,660 466	2.819,481	69
Kentucky	63,790,675	89,953,432	41
Georgia	21,766,668	32,081,312	47
Alabama	18,828,177	30,054,620	59
Mississippi	16,346,925	23,524,792	43

Let us observe also the gains in cotton and live stock.

COTTON.—BALES.

	1870.	1880.	Per Cent. Increase.
Georgia	473,934	814,441	75
Alabama	429,482	699,654	62
Mississippi	564,938	955,808	69

LIVE STOCK.

	1870.	1880.	Per Cent. of Increase.
New York	5,286,421	5,422,238	2
Pennsylvania	4,484,748	5,251,304	17
Virginia	1,736,360	2,392,360	37
Massachusetts	387,932	469,025	20
Kentucky	3,891,583	4,558,089	17
Georgia	2,275,137	3,139,101	38
Alabama	1,606,299	2,586,221	61
Mississippi	1,724,295	2,398,934	38

We have looked into the statistics of the following Counties lying in the States named, to wit:

In Georgia.—Fulton, Cobb, Campbell, Douglas, Paulding, Polk, Haralson and Carroll.

In Alabama.—Cleburne, Randolph, Clay, Cherokee, Calhoun, Talladega, Etowah, St. Clair, Shelby, Blount, Jefferson, Walker, Fayette, Tuscaloosa, Lamar and Pickens.

In Mississippi.—Monroe, Lowndes, Noxubee, Chickasaw, Clay, Oktibbeha, Winston, Calhoun, Sumner, Choctaw, Grenada, Montgomery, Attala, Leflore, Carroll, Holmes, Sunflower, Bolivar and Washington.

These counties have an aggregate area of about twenty-eight thousand square miles. Their population in 1880 was over 728,000 —a gain of 212,000 in ten years.

Their products in 1880 were 503,438 bales (400 lbs. each) of cotton, and 18,328,238 bushels of cereals; besides wool, potatoes, live stock, fruits, etc., etc. But, although the products generally of 1880 are about double those of 1870—showing a very rapid advance—the figures of 1880 are still below those of 1860, which should be regarded as giving a juster representation of the capacity of these counties than do those of a later date. The difference in cotton, however, is only about thirty-five hundred bales; the difference in cereals is relatively greater. The value of the farms, implements and live stock in these forty-four counties, in 1860, was $121,176,342.

But a more definite conception of the productiveness of a part of this region may be found by an examination of the following statistics, which we find in a pamphlet on Alabama, by Mr. John T. Milner. They are taken from the Census of 1860. We will select six of the counties in Alabama, in this belt, and compare the value of their products with six of the " richest and most noted " counties in Ohio, Indiana and Illinois, and also with Augusta county, Virginia, one of the largest and richest counties of that State.

Counties.	Value of Farm products.	Per cap. value. of Farm products.
Shelby	$581,005	$40 89
Jefferson	576,658	48 00
Walker	370,629	35 00
Blount	206,876	18 72
Winston	74,722	20 75
Talladega	1,258,168	53 04
	$3,068,058	$216 40

Per capita average of all, $36 06

Counties in other States.	Value of Farm products.	Per cap. value.
Marion, Indiana	$887,061	$28 77
Sangamon, Illinois	1,571,163	49 00
Franklin, Ohio	991,100	33 00
Wayne, Indiana	867,549	28 09
St. Clair, Illinois	1,521,896	40 00
Butler, Ohio	1,671,132	46 05
	$7,509,901	$224 91

Per capita average of all $37 48

Augusta Co., Virginia	$944,619	$34 00

It may be noted that the total valuation of the products of Talladega County, Alabama, was $1,258.168, whilst that of Augusta County, Virginia, was $944,619. The special comparison in the above table, however, is not in the gross, but in the average products *per head* of population (white and black), in which respect the difference is very small.

Another notable fact is that, before the war, Georgia, Alabama and Mississippi produced more *meat* per capita than did Ohio, Indiana and Illinois. It was the custom then for the planters to raise their own meat. More cattle and hogs were raised in the Southern than in the Northern States.

PRODUCTION OF ALABAMA AND OHIO COMPARED.

In this connection let us glance at Montgomery County, Alabama, which, although not in the belt we are studying, is on the same prairie formation crossed by the Georgia Pacific Railway on the edge of Mississippi. Compare it with Butler Co., Ohio, which "shows the best record of any county in the West." In live stock, Montgomery had $1,748,273; Butler, $1,333,592. Montgomery had 63,134 hogs; Butler, 51,640. Animals slaughtered—Montgomery, $336,915; Butler, $318,274. In grain, Butler was considerably ahead; but in roots Montgomery lead. Montgomery doubled Butler in the production of wool, and had its cotton crop to show besides. The total value of the crops of Montgomery County was $3,264,170; those of Butler, only $1,671,132—a handsome triumph for the Alabama county! And yet Montgomery is not up to the average of the prairie counties of Alabama. Its productions, which nearly double those of the best county in Ohio, and of the best *two* counties in Illinois, are not nearly equal to those of either Marengo or Douglas counties. This was the record in 1860, and it can be repeated in the future.

The crop products of Alabama and of Mississippi, in 1860, were surpassed in value only by those of New York, Pennsylvania and Illinois, and but three States equalled them in the product *per capita.*

These brief statements are full of meaning and of promise for the future of this Railway. But none of these three States has ever approached its own maximum productive capacity. Hence, without indulging in any fanciful notions, and viewing the matter only in the light of what is now going on in many parts of our own and other countries, we may fairly anticipate a large and increasing bulk of agricultural produce in these States.

THE AGRICULTURAL PRODUCTION OF THE FUTURE.

American agriculture runs through the same cycle in all the States—careless farming on rich lands, exhaustion and restoration. In some of the older States the cycle has been completed; in others it is more or less advanced. We formerly heard of the *inexhaustible* prairie lands of Illinois, and were told that manure was simply a nuisance. Now we hear of their decadence. The lands in many of the Southern States had passed the point of exhaustion before the war, and were in process of restoration; the statistics above presented show their prosperity. During the war they were again exhausted; but the statistics of 1880 show that they are now rapidly recovering, and they will ultimately go far beyond any point heretofore attained as regards the quality and variety of their products.

It may be said of these lands generally—a remark which cannot be made of the Illinois prairies—that the mineral composition of their subsoil is identical with that of the top soil in its original state. The subsoil, therefore, is now richer than the surface soil. As a rule, deep ploughing, together with the use of calcareous fertilizers, and of such vegetable manures as clover and peas (chiefly the latter), will greatly increase the product of these lands.

The means of improving the soil are at hand. We saw but one deposit of limestone in the Metamorphic region; but from the Blue Mountain to the Mississippi Bottom it is everywhere within easy reach, and may be burnt very cheaply. We believe in lime, made from selected limestones, as a direct feeder of plants, as well as an important chemical and mechanical agent.

Marls and green sands are found in the Cretaceous and Tertiary formations. They probably exist in such quantity, and of such quality, as to render them useful, but have not been sufficiently explored or tested to enable us to speak positively concerning them. The *Rural Mississippian* expresses confidence in the great value of those found in Mississippi. Sulphuric acid will be obtained from the pyrites of the Metamorphic region, and phosphatic manures ought to be manufactured cheaply. The coal deposits will ultimately furnish ammonia.

The extraordinary value of cotton seed as a manure, and as food for cattle, is now becoming generally understood. The extraction of the oil, which already constitutes an important industry, makes scarcely any reduction in its value as manure, and the residue, cotton-seed cake, is in every way superior to the linseed oil-cake.

Sir J. B. Lawes, of England, found that the manure from feeding a ton of cotton-seed cake was worth $27.86 in gold. The seed constitute about two-thirds in weight of the entire yield of the cotton plant, which would give to the Southern States an aggregate of 3,080,000 tons of seed annually, to be returned to the land in some form as manure. What a source of improvement is here!

It is now estimated that an intelligent use of the seed will add at least one-third to the value of the cotton crop. The lint (or fibre) draws very few elements from the soil, and leaves much of the plant to be returned in a more available form than that in which it originally existed there. For example, in order to produce 500 pounds of cotton, there must be produced 4,500 pounds of matter (dry weight). These 4,500 pounds contain 240 pounds of mineral matter, of which the lint, or cotton proper, contains only about 6¼ pounds. The planter, therefore, sells only 6 pounds of his soil and keeps 236 pounds, which he may return to his land after extracting a profit from it by feeding it to his cattle.

The *Rural Mississippian* declares that it is possible to make four bales of cotton to the acre, and Mr. W. H. Finley claims to have done so.

Wheat is raised to some extent in this region; both soil and climate are adapted to its cultivation, and there will be an increase in its production. It is also a good country for oats, especially for the winter variety.

THE SOUTH AS A GRASS COUNTRY.

The usual standard authorities deny the practicability of establishing a permanent, dense sod in the Southern States, except in rare spots where the ground is moist and shaded. Mr. C. L. Flint goes so far as to doubt the practicability of forming a close turf south of the latitude of Baltimore—forgetting Kentucky and the Valley of Virginia, where there are areas of sod equal to the best in England. We also found at Greenville, Winona, Starkeville and other points in Mississippi, a grass sod which, for density and freedom from foreign growth, we have never seen surpassed. At all these places Bermuda grass constituted the principal sod. The point to be regarded in the South is the selection of grasses adapted to that section, not to States farther north. Mr. Charles Mohr, of Mobile, a most competent observer, publishes the statement that he has himself collected in South and Middle Alabama 132 species, belonging to 53 genera, of native grasses. He includes in the list the Bermuda and a few other imported grasses which have become naturalized. This Bermuda grass was an immense acquisition. It grows anywhere; bears any amount of drought and close pasturing; is very sweet and nutritious when young; contains 14 per cent. of albuminoids, according to Dr. Ravenel's analysis; and on rich lands is reported to yield more hay than does Timothy. The Bermuda grass will take fast hold in the most hopeless-looking gullies, and in barren sands where no other grass will grow; and once lodged it holds on and spreads, even under hard pasturing. The Lespedeza is its only rival for possession of the soil.

The Kentucky Blue Grass will cohabit with the Bermuda, and grows in the winter while the Bermuda is dormant. Lespedeza, Orchard Grass, Kentucky Blue Grass, Timothy and the Panic grasses do well except when mowed or pastured closely in summer—in which event most of them are in danger of perishing. The Johnson grass is a prodigious grower, is perennial, and for all purposes is, perhaps, the most profitable grass. The indications are that Georgia, Alabama and Mississippi can produce more good hay *per acre*, than any Northern States of the same area; perhaps twice as much. The mild winters and wet springs, and the greater size of some of the Southern grasses, such as the Johnson, Guinea, Gamma, Lucerne, Munro, etc., render this probable.

The Lucerne, which does not succeed well in the Northern States, or even in England, flourishes in these States; and, when sown on suitably prepared land, it defies drought. It thrives under the Southern sun, here, as it does in France and Italy. Each acre may be expected to yield five tons of hay in a season. The Gamma is another grass which grows with great luxuriance. The seed stock grows 5 to 7 feet in height, and the leaves furnish an enormous quantity of palatable forage as nutritious as corn fodder. The Crab grass is a true summer grass, which grows spontaneously in the cultivated fields, and comes in when most needed.

Dr. Phares gives an account of a grass (*Panicum agrostoides*), locally called Munro grass, which is thought capable of yielding 15 tons of hay in a season. Mr. Munro, for whom it was named, reports a product of 23,870 lbs. hay per acre in one season on his own land. It is not so vigorous farther north.

Clover, Millet, Timothy and other standard grasses may all be grown in this region.

The native grasses, which constitute the principal winter pasturage, far more than compensate for the suffering of the other grasses in summer. They may be so managed as to afford good pasture at all seasons, and to render necessary only a small provision of dry forage for winter use, thus giving to these States an immense advantage over those farther north. We saw green and growing Kentucky Blue Grass, near Jackson, Miss., last February. Mr. C. M. Howard says, in his book on Grasses, that he has sold fat Ayrshire cattle which had never had a mouthful of feed except what they gathered for themselves in the fields.

The hay crop has proved exceedingly profitable to the few who have engaged in it, and the yield has never been surpassed.

The dairy business is developing rapidly in Mississippi under the lead of Mr. Wm. B. Montgomery, of Starkeville, and other intelligent pioneers. Mr. Montgomery's herd of Jerseys has become famous, and their butter record is among the highest. The amplest testimony in regard to grass, hay and cattle may be found in the Hand Books and other State publications of the three States above named. There are, also, two excellent works on Southern grasses by Mr. C. M. Howard, of Georgia, and Dr. D. L. Phares, of the Agricultural College of Mississippi; to which should be added Dr. Charles Mohr's treatise in the Hand Book of Alabama.

Most of the cattle we saw in these States were superior to those observed east of the Blue Ridge farther north, being generally of medium size and well formed; besides which is a class that are extra large and not badly formed. We saw many native oxen that could be grazed to 2,000 lbs. gross weight. The smaller breed would weigh 1,000 lbs. at 3 years old. At the present rate of progress these States will ere long produce hay, butter, cheese and beef more cheaply than these articles are now produced anywhere in higher latitudes.

These facts point the way to prosperity, and demonstrate that these States are destined to become the largest producers of hay and cattle. The lands will then be permanently improved from their own resources, after being helped in the earlier stages.

Here, then, we find three States that are of the first class, in point of soil and size; that are capable of producing every crop that is grown farther north; that are able to surpass New York and New England in grass, hay, cattle and milk products, and that are the home of the great Southern money crop, cotton—what room is there for doubt that here is to be an empire of agricultural wealth!

MANUFACTURES.

In former years Georgia, Alabama and Mississippi were planting—and not manufacturing—States, except to a very limited extent. Now there is a strong tendency in the direction of manufactures. We have not had access to the Census tables for 1880, but we find in the local publications some encouraging statements. The Hand Book of Georgia, published in 1876, reports that there were in the State at that time 36 cotton factories; 14 woolen factories; 1,375 grain mills, and 734 saw-mills—besides factories for the manufacture of iron, leather, earthenware and turpentine.

The Alabama Hand Book reports 18 cotton factories in that State in 1878. Others have arisen since. Besides these are the iron and wood works, and others of less note.

Major Wall, of Mississippi, reports manufactures in cotton, wool, wood, cotton-seed, clay, etc., amounting, in 1880, to nearly $7,000,000 capital invested, and over $12,000,000 in products.

These facts forecast a great manufacturing future. Whatever art, energy and capital may effect in overcoming natural disadvantages, nature will prevail at last. The best natural facilities determine where shall be the greatest centres of manufacturing, and, as a rule, the location of the crude materials determines where the chief factories must ultimately be established. Illustrations of this are now seen at Anniston and Birmingham. The want of a manufacturing population postpones the result, but does not defeat it.

Not to mention others, the indications may be relied on that industries in wood, iron and cotton will arise in this region in great variety and amount, because the raw materials, the fuel and the power—both steam and water—are to be found here in close association. Labor is and must continue to be cheap, because food is easily produced; and because the incidental expenses of the laborer, namely, for clothing, fuel, &c., are less than farther north.

SOCIAL CONDITION.

The governments of these States are now well administered. Social order is good. The white and black are at peace. All the best institutions of society are here. There is a large class of people of intelligence and refinement. The ascerbities of the past and sectional prejudices are fast passing away, and every encouragement is given to immigration, capital, and enterprise, all of which are now rapidly flowing into these States.

SUMMARY.

This report shows that the region traversed by the Georgia Pacific Railway is generally elevated, rolling and healthy, and that it is remarkably rich in minerals, forests, and agricultural capabilities. Its outcome in all these particulars is beyond computation. It is also shown that the route of the road—cutting as it does across all the geological formations, with their interstratified mineral beds, across all the valleys and rivers, and across all north and south lines of transportation—possesses advantages rarely enjoyed by any one line.

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APPENDICES.

EXPLANATORY APPENDICES.

by J. S., C.,

A.—SCIENTIFIC AND TECHNICAL TERMS EXPLAINED.

B.—GEOLOGICAL NOTES ON SPECIAL POINTS.

C.—SOME CHEMICAL NOTES ON SULPHURIC ACID, PHOSPHATES AND IRON.

APPENDIX A.

SCIENTIFIC AND TECHNICAL TERMS EXPLAINED.

Acadian Epoch.—Lowest division of the Silurian Age.

Ages.—The greatest subdivisions of geological time.

Albite.—A species of feldspar containing soda, and white in color.—See *Feldspar.*

Alluvium.—Material transported and deposited by running water.

Alumina.—The base of clay, slate, &c.

Aluminum.—A metal contained in Alumina.

Anthracite.—A hard, black variety of mineral coal, from which the volatile matter has been expelled by heat, under heavy pressure—nearly pure carbon.

Ammonia.—A compound of nitrogen and hydrogen, sometimes called spirits of hartshorn.

Amphibole.—A name of hornblende.

Argillaceous.—Abounding in clay—as argillaceous iron ore.

Argillite.—Hard clay slate—such as roofing slate.

Asbestos.—See *Hornblende.*

Baryte.—Sulphate of Barium, employed in making white paint.

Bed.—A distinct layer among rocky strata—as a bed of ore, a bed of coal, &c. See *Seam.*

Bituminous.—Containing a mixture of volatile, combustible oils and resins—as bituminous coal.

Blende.—An ore of zinc, consisting of zinc combined with sulphur.

Bog Ore.—A mass of iron ore deposited in low places, from chalybeate waters.

Breccia.—A mass of angular fragments of any mineral cemented together. It differs from a conglomerate, which has its fragments water-worn.

Brown Coal.—Another name for Lignite—a semi-formed bituminous coal.

Caking Coal.—A variety of bituminous coal which fuses into a pasty mass.

Calcareous Minerals.—Composed in part of carbonate of lime—as calcareous shales, cherts, &c.

Calcite.—Sometimes limited to crystallized carbonate of lime; but properly includes all moderately pure limestones.

Calciferous Sandstone.—A sand-rock containing more or less carbonate of lime.

Cannel Coal.—A variety of bituminous coal, of compact structure, with but little lustre, and which burns with a brilliant flame.

Carbon.—The material of diamond, graphite, charcoal and coke.

Carbonic Acid—(or Carbon Dioxide).—An acid gas produced by burning carbon, and also liberated from limestone or any other carbonate when treated with a strong acid.

Carbonate.—A mineral containing carbonic acid in combination.

Chalcopyrite:—An ore of copper, of greenish yellow or bronze color, consisting of copper and iron combined with sulphur.

Chalk.—A soft, granular form of carbonate of lime.

Chert.—A silicious rock of porous structure, deposited from solution in water.

Cherty Sandstone.—A mixture of sand and chert.

Chlorite.—A soft, green mineral of foliated structure, resembling the green varieties of talc, but harder; composed of silica combined with magnesia, alumina and iron.

Chloritic Rocks.—Containing a large percentage of chlorite, which gives them a green color.

Clinkers.—Semi-vitrified masses of ashes and slate, produced in burning some varieties of impure coal.

Coke.—The residuum of bituminous coal after the volatile matter has been expelled.

Corundum.—The crystallized form of pure alumina; when blue called sapphire; when red, oriental ruby, &c. The granular form is called emery.

Country Rocks.—The rocks immediately underlying the surface of any particular area.

Cretaceous.—Chalky—(from *creta*, chalk).

Cyanite.—An old way of spelling *Kyanite.*

Damourite.—A variety of hydromica.

Delta.—A triangular tract of alluvial land between two mouths of a river.

Detritus—Debris.—The loose material, such as pebbles, clay, sand, &c., worn down from rocky masses.

Dip.—The angle by which the face of a sloping stratum varies from a horizontal plane.

Dolomite.—A double carbonate of lime and magnesia. When pure it consists of 54 per cent. of carbonate of lime and 46 per cent. of carbonate of magnesia.

Dolomitic Limestone contains variable quantities of carbonate of magnesia. Many of the finest marbles are dolomitic.

Dye-Stone.—A term applied to a red oxide of iron—red hematite.

Emery.—See Corundum.

Epidote.—A very hard, yellowish-green mineral, composed of silica combined with alumina, iron and lime.

Fault.—A dislocation of strata along a fissure.

Fauna.—The whole collection of animals of any region, or of any geological period.

Feldspar.—A mineral of several varieties, containing silica combined with alumina, and either potash, soda or lime. Disintegrated feldspar forms *Kaolin.*

Flora.—The collection of plants of any region, or of any geological period.

Fossils.—The relics of plants and animals found in rocks.

Galena.—The common ore of lead, consisting of lead and sulphur.

Gangue.—The mineral matter accompanying metallic ores in veins—also called *Vein-stone.*

Garnet.—A crystalline mineral, most commonly of a deep red or crimson color. Found abundantly in mica schists, gneisses, &c.

Gneiss (pronounced *nice*).—An indistinctly stratified rock, consisting of a mixture of quartz and feldspar, with either mica or hornblende, or both. It passes gradually into granite on the one hand, and into schist on the other.

Granite.—A hard rock, consisting of quartz, feldspar and mica, in distinct crystals.

Green Sand.—A mixture of glauconite (hydrated silicate of iron, alumina and potassa) with sand, clay and a little phosphate of lime. Abundant in the Cretaceous period, and employed as a fertilizer.

Hornblende.—A crystalline mineral, containing silica combined with iron, lime, alumina, and sometimes other substances. Varieties free of iron, and of fibrous structure, constitute *Asbestos.* The dark varieties, containing iron and lime, form dark, fertile soils.

Isinglass.—A name of *Mica.*

Kaolin.—A hydrated silicate of alumina; white porcelain clay. See *Feldspar.*

Kyanite.—A mineral generally found in blue-bladed crystals; a pure silicate of alumina.

Lignite.—Semi-formed coal, which retains its woody structure.

Limonite.—Brown hematite ore.

Lode (also spelled *Lead*).—A vein or group of veins of metallic ore.

Malachite.—Green carbonate of copper.

Marble.—A fine quality of carbonate of lime.

Marl.—A mass of precipitated carbonate of lime, or of shells cemented by carbonate of lime. A valuable fertilizer.

Mica (called also *Isinglass*).—A foliated mineral, of which there are several varieties; one of the constituents of granite, gneiss, &c.

Mineral Charcoal.—A soft coal containing but little bituminous coal.

Mundic.—A mining term applied to both pyrite and chalcopyrite as found in veins.

Paleontology.—The branch of science which treats of fossil plants and animals.

Peat.—A mass of decaying vegetable matter, as found in swamps.

Plant.—A technical term applied to a manufacturing establishment with all its appurtenances, as a furnace or rolling mill with their respective fixtures.

Plateau.—An elevated plain or table land.

Protean (variable).—The old name of the Clinton formation; also applied to beds of shale and slate in variegated colors, and, sometimes, to a portion of the Sub-Carboniferous rocks.

Pudding-Stone.—A conglomerate with colored pebbles.

Pyrite.—Iron Pyrites. A compound of iron and sulphur; a very hard, bright yellow mineral.

Quartz.—A pure form of silica. A constituent of granite.

Quartzite.—Metamorphosed sandstone.

Rock.—Any large mass of mineral matter, whether hard or soft, is called *rock* by geologists.

Schist.—A stratified metamorphic rock, less fissile than slate, and passing gradually into gneiss.

Seam.—A layer of mineral matter between two others of a different kind, as a seam of coal. See *Bed.*

Sedimentary Rocks.—Those deposited by the mechanical action of water.

Shale.—Soft, brittle, argillaceous rock, having an irregular slaty structure.

Shell Marl.—A mixture of shells with carbonate of lime; found in the tertiary rocks, and valuable as a fertilizer.

Siderite.—Crystallized carbonate of iron.

Silica.—The most abundant of all mineral substances formed, as flint, chert, sand, &c., and combined in silicates of alumina, lime, iron, &c.

Silt.—The fine sediment deposited as soft mud in the bottom of quiet waters—the finest form of alluvium.

Slate.—A hard argillaceous rock, which splits in regular layers.

Smelting.—Reducing a metal from its ores.

Stalactite.—A pendant cylinder or cone of carbonate of lime, formed in the roofs of limestone caverns.

Stalactic Ore.—Brown hematite ore, formed like stalactites.

Stalagmite.—A deposit formed on the bottom of a cavern by the dripping of limestone water.

Stratum (plural *Strata*).—A distinct layer of mineral matter deposited by water.

Strike.—The course or bearing of the upturned edges of strata—always at right angles to the dip.

Syenite.—A granitic rock containing hornblende instead of mica.

Talc.—A soft foliated mineral, often in scales like mica; feels greasy under the fingers. When massive, it is called steatite or soapstone. It is composed of magnesia combined with silica—a valuable fire-stone.

Terrane.—"This term is used for any single rock, or continuous series of rocks of a region, whether stratified or not. It is applied especially to metamorphic and igneous rocks, as a *basaltic terrane.*"—(Dana.)

Trap.—An igneous rock, of columnar structure. A term also applied to several varieties of igneous rocks thrust up as dykes through stratified rocks.

Trend.—The general direction of a range of mountains, of a coast-line, &c.

Unconformable Strata are those which come in contact, without being parallel, or not having the same dip.

APPENDIX B.

GEOLOGICAL NOTES.

As supplementary to what has been written on the subject, we propose to add a few explanatory notes on some special points in geology.

I.—*Origin of Rocks.*—There are comparatively few rocks exposed to view on the surface of the earth which have not been deposited by either the mechanical or chemical action of water.

II.—*Metamorphic Rocks* are generally stratified, though some of the older gneisses have been so nearly fused by metamorphic agents as to have assumed the structure and texture of granite, as, for example, the Stone Mountain of Georgia, and some rocky beds near the line of the Georgia Pacific Railway.

III.—The chief agents of metamorphism are heat and water acting conjointly under heavy pressure. Experiments have proved that water under high pressure reduces many of the most infusible rocks to a pasty or plastic condition, at a temperature below red heat. A mineral mass kept in such condition for a long period would naturally assume such a crystalline structure as we find in nearly all metamorphic rocks.

IV.—*Fossiliferous Rocks* are distinguished by the remains of plants and animals imbedded in them. During the earliest geologic ages there were certainly no animals—and probably no plants—in existence, as we infer from their absence in the oldest rocks. And during the periods when the earliest fossil rocks were produced, all animal and vegetable life appears to have been confined to the water, as evinced by the fossil remains found in these rocks.

V.—*The Devonian Age* is the first in which forests of land plants, such as lycopods and tree-ferns, became conspicuous, and in connection with these the first air-breathing animals appeared as insects. Then, in the Carboniferous Age, new land plants and more extensive forests were added, and with them came a few cold-blooded air-breathers, as amphibians and reptiles. Carbonic acid, which is the chief article of plant food, was too abundant in the atmosphere to be safely breathed by the more highly organized animals, until it had been removed by the production of the coal plants of the Carboniferous Age. Even then, only the lowest class of mammalia, the marsupials—akin to the opossum and kangaroo—are found to have lived in the succeeding Mesozoic Age.

VI.—*The petrification of fossils* consists in the gradual decay of their vegetable or animal substances and the substitution of mineral matter, which gradually takes the place and assumes the form of the original body. The most common petrifying minerals are *carbonate of lime*, as exemplified in the shells and corals of the Trenton and Sub-Carboniferous limestones; *silica*, often found in petrified wood; and *oxide of iron*, as seen in the fossil ores of Red Mountain.

VII.—*The History* of the rocks embraced in our discussions begins with the earliest probable history of this continent, when the whole area above water was not much more extensive than the region over which the Archæan rocks are now exposed to view. The Ohio and Mississippi valleys were then, doubtless, covered by the waters of the ocean.

VIII.—*Ages, Periods and Epochs* of geological history have their relations to one another concisely exhibited in the following table, compiled from Dana's Manual of Geology. Like the geological sections, this table should be read from the bottom upward. It will aid the reader in getting a clear view of what we have written about the geology of Georgia, Alabama and Mississippi.

TABLE OF GEOLOGICAL FORMATIONS.

Compiled chiefly from Dana.

Ages.		Periods.	Epochs, or Minor Groups.
Age of Man.		Quaternary	20 c. Recent. 20 b. Champlain. 20 a. Glacial.
Age of Mammals.		Tertiary	19 c. Pliocene. 19 b. Miocene. 19 a. Eocene.
Age of Reptiles.		Cretaceous	18. Cretaceous (chalk).
		Jurassic	17. Jurassic, } Coal bearing.
		Triassic	16. Triassic, } Coal bearing.
Carboniferous, or Age of Acrogens.		Permian	15. Permian—some coal.
		Carboniferous, or Coal Measures	14 c. Upper Coal Group. 14 b. Lower Coal Group. 14 a. Conglomerate Coal Group.
		Sub-Carboniferous	13 b. Upper Sub-Carboniferous. 13 a. Lower Sub-Carboniferous.
Devonian, or Age of Fishes.		Catskill, or Upper Devonian	12. Catskill.
		Chemung, or Middle Devonian	11 b. Chemung. 11 a. Portage.
		Hamilton, or Lower Devonian	10 c. Genesee. 10 b. Hamilton. 10 a. Marcellus.
		Corniferous	9. Corniferous.
Silurian, or Age of Invertebrates.	Upper Silurian.	Oriskany	8. Oriskany.
		Lower Helderberg	7. Lower Helderberg.
		Salina	6. Salina.
		Niagara	5 c. Niagara. 5 b. Clinton. 5 a. Medina.
	Lower Silurian.	Trenton	4 c. Cincinnati. 4 b. Utica. 4 a. Trenton.
		Canadian, (Upper Cambrian ?)	3 c. Chazy. 3 b. Quebec, Dolomitic. 3 a. Calciferous.
		Primordial, or Lower Cambrian	2 b. Potsdam. 2 a. Acadian.
Archæan, or Eozoic Age.		Archæan, or Metamorphic	1 b. Huronian. 1 a. Laurentian.

HISTORY OF GEOLOGICAL NOMENCLATURE.

A brief account of the origin of the geological terms we have employed will help to fix their application in the minds of our readers. Some of the names at present generally employed in geological science are partly local or geographical, and were taken originally from the localities at which the several divisions of the rocky strata were first studied, or where they have been found to be conspicuous; others are lithological, as Calciferous, Corniferous, &c.; while yet others are paleontological, and were derived from their prevailing fossils, as Age of Fishes, Age of Reptiles, &c.

The names of the *Ages* are mostly of English origin, but those of the *Periods* and *Epochs* originated chiefly with the New York and Canadian Geologists, because these took the lead in the earlier geological explorations in North America. Whatever may have been the origin of these names, however, they have been so long in use, and have been so universally adopted by the authors of our standard text-books, that they are now a part of the language of Geological Science.

ORIGIN of the terms employed in the foregoing table, beginning with the LOWEST.

Archæan.—This term means *ancient*, or the *beginning* of geological history, and is applied to the oldest rocks of the whole series.

Eozoic—(meaning the dawn of life)—is applied to the same rocks.

Laurentian.—From the St. Lawrence, or the Laurentide Hills of Canada, where its rocks have a bold outcrop.

Huronian.—Derived from Lake Huron, where its rocks are found in abundance.

Primordial.—The first of the series of distinctly fossiliferous rocks.

Cambrian.—A name given by English geologists—from Cambria, a province of Wales, where these rocks abound. Some make it include the Lower Silurian.

Acadian.—From Acadia—an old name of Nova Scotia.

Silurian.—So called by English geologists because the rocks of this age are most prominent in the country of the ancient tribe of Silures, on the borders of Wales.

Potsdam.—From a locality in New York, where its sandstones are prominent.

Canadian.—This group of rocks is prominent in the southern part of Canada—hence the name.

Calciferous.—So called from a calcareous sandstone which characterizes it in New York.

Quebec.—So called from a bold development at Quebec, Canada. It is also called *Levis*, from Point Levis, opposite Quebec.

Trenton.—From Trenton Falls, New York, where the limestone has a bold outcrop.

Utica.—From Utica, New York.

Cincinnati.—Also called *Hudson River Shales*, local names from developments at these points.

Niagara.—The name of the group of rocks over which Niagara Falls are precipitated.

Medina.—A sandstone formation prominent at Medina, New York. Its lower bed is called "Oneida Conglomerate." Its upper bed in Virginia carries fossil ore.

Clinton.—From Clinton, Oneida Co., New York. This formation is remarkable for the fossil and red hematite ores found throughout its whole extent. It was formerly called the "Protean Group," from the variegated color of its rocks.

Salina.—From Salina, a suburb of Syracuse, New York, so called from its salt manufactures. Wanting in Alabama.

Helderberg.—A limestone formation of the Helderberg Mountains, New York. Not found in Alabama.

Oriskany.—A sandy formation found at Oriskany Falls, New York, where it has its typical development. Not found in Alabama.

Devonian.--Largely developed in Devonshire, England, where it received its name many years ago. One of its beds is the "Old Red Sandstone," rendered famous by Hugh Miller.

Corniferous.—So called from the numerous nodules of hornstone found in it.

Marcellus, *Hamilton*, and *Genesee* are names derived from localities in New York.

Genesee.—"All through the Western and Southwestern States there is always found a black shale, which is often the only representative of the Devonian rocks. This is generally considered to be Genesee (10 c)." It is found at numerous points in Alabama.

Chemung and *Catskill.*—Local names in New York.

Carboniferous.—Named from its coal. Prof. Wm. B. Rogers, after his latest investigations, divided this Age into *Lower*, *Middle* and *Upper Carboniferous*, and *Permian.* His lower and middle divisions are usually called Lower and Upper Sub-Carboniferous, and his upper division is generally called the Coal Measures.

The Coal Measures are again divided into Millstone Grit, or Conglomerate Group; and Lower and Upper Coal Groups. The Permian is named from Permia (Perm), a district of Russia, where this formation was first studied.

Millstone Grit is an old English term applied to the conglomerate sandstone which forms the base of the Coal Measures in England, Ireland, and other European countries, and which has been employed for making millstones. In America it is very widely extended, sometimes as conglomerate, sometimes as a single bed of hard sandstone, and sometimes divided with intervening beds of shale and coal; hence the terms conglomerate, and inter-conglomerate group. The higher beds of conglomerates and sandstones in the coal are softer and more micaceous.

Mesozoic.—A transition Age between that in which nearly all animals were marine, and that in which terrestrial animals became abundant.

Triassic.—An English name, given on account of its three-fold division in Europe.

Jurassic.—From Mount Jura, where the formation is finely displayed.

Cretaceous.—From *creta* (chalk), which abounds in England and France. In the Mississippi Valley, a soft limestone generally takes the place of chalk.

Tertiary.—The third of the grand fossil divisions.

Eocene, *Miocene* and *Pliocene* are terms applied by Sir Charles Lyell to three divisions of the Tertiary Age, but not very applicable in the United States.

Quaternary is the fourth grand division of geological time, and embraces the period of Man.

Glacial.—The period when glaciers extended over a large part of the Northern Hemisphere.

Champlain.—Named from Lake Champlain, where this period was first carefully studied.

Recent.—The period still going on.

The nomenclature of geology has long been kept in a state of confusion by the use of local geographical names for the subdivisions of rocks of different ages. Lithological names have to some extent had a similar influence. But this confusion, though still prevalent to a great extent among the State geologists of this country, has been somewhat checked by Professor Dana's effort to give systematic and permanent form to both nomenclature and notation, as exhibited in the foregoing table; by the use of the same system by Professor Le Conte in his Geology, and by its more general adoption in Dr. Macfarlane's Geological Railway Guide.

Dana's system of notation by numbers and letters is applicable to all parts of this Continent, and is far superior to any other system yet devised. Local, or State systems may serve well for temporary use, but they cannot last long.

IX.—Previous to what we call the Archæan Age, there was doubtless a time when the rocks of the earth were in a fluid or semi-fluid condition, and when all the uncombined water pervaded the atmosphere as steam. Then followed a time when the cooling globe had a solid crust formed on its surface, which was gradually broken up by contraction of the interior mass. The rugged surface thus produced ultimately became cool enough to condense the water into streams and lakes and seas. Conditions were now favorable for the formation of stratified rocks—by the abrasion of the higher, and the filling up of the lower areas—long before plants or animals could have endured the still intense heat.

X.—During the Archæan Age there may have been plants enough to produce its beds of *graphite*, which has about the same composition as anthracite coal, but is more highly metamorphosed. While the limestones of the Archæan Age were forming, some of the simplest animal organisms (*e. g.*, Eozoä) are believed to have lived in the waters.

XI. The beds of magnetic and specular iron ores of Archæan Age—at least many of them—were most probably deposited originally from water, as hydrated oxide or carbonate of iron, and subsequently metamorphosed to their present condition. We know that precipitates of peroxide and carbonate of iron when heated together combine as magnetic oxide. This seems to imply pre-existing vegetable matter. (See Note XXI.)

XII.—Extensive contortions, foldings, fractures and upheavals of the Archaean rocks must have occurred before the newer rocks were deposited on them. Then, additional disturbances followed in connection with subsequent revolutions—such as those at the close of the Devonian and the Carboniferous ages. The contortions and foldings of strata are manifestly the result of lateral compression, more than of vertical upheaval.

XIII.—On our geological map the colors indicate where the rocks of the different geological ages which they severally represent come to the surface.

On the State Geological Map of Georgia, all of the metamorphic rocks are represented as Silurian; which we regard as a serious error—originating, no doubt, in the fact that some of the primordial shales in Georgia and Alabama are similarly metamorphosed when they border on the metamorphic area. Along the margin of Choccolocco Valley, for instance, the Silurian beds have been depressed by a line of fault, and at the same time a closed anticlinal fold of Archæan rocks appears to have been greatly elevated and thrown over upon them. (See Geological Section, No. I.)

XIV.—The nomenclature of the Archæan formations is geological as to its two main divisions. "Laurentian" (1 a), is a name given in 1854, by the Canadian geologists, to the terrane forming the Laurentide hills of Canada; "Huronian" (1 b), was given to the schistose and slaty terrane which overlies the Laurentian, along the north shores of Lake Huron. Subsequently the upper part of the Laurentian was called "Norian," a lithological name derived from the mineral Norite, of which it is largely composed. The upper portion of the Huronian has also received the name "Montalban," from the White Mountains, where it is heavily displayed. This last is supposed to be the part of the Huronian to which belong the gold-bearing rocks of the Archæan belt in Virginia, North Carolina, Georgia and Alabama.

The horizons of these four divisions, as already stated, are not well defined in either Georgia or Alabama; hence we have employed only the more general divisions. There being no fossils in this age, the classification is based entirely on lithological peculiarities, which are not very reliable except for limited areas.

XV.—The geological formations above the Archæan are all fossiliferous. Their relative ages are determined in three ways: (1.) By their order of superposition, where no inversions have occured. (2.) By lithological features, which aid in distinguishing strata of different ages, but cannot be relied upon at points remote from one another. For example, several beds that are sandstones and shales on the Appalachian border of the great Coal Field, become limestone in the interior. On this point Dr. Macfarlane says: "To a superficial observer, the remarkable substitution of great sandstone and conglomerate deposits under the coal measures in the East, for generally limestone deposits under the coal measures of the West, must seem inexplicable. But the simple explanation is, that all the Sub-Carboniferous sand-beds of Pennsylvania, formed near the old continent, thin away, and gradually disappear before they reach the

Mississippi; while the five great Sub-Carboniferous limestones of Illinois, Iowa and Missouri, formed in a deep quiet sea, on the contrary, thin away in going eastward—40 feet in Westmoreland Co., and 25 feet in Somerset Co., Pennsylvania—and totally disappear before reaching the Schuylkill and Lehigh rivers. But the same limestone deposits thicken southward to 600 and 1,000 feet in Virginia, and even more in Tennessee." (3.) Fossil remains afford the most reliable means of determining the relative ages of rocks, since every age has had its peculiar flora and fauna. But due allowance must be made for the varying depth and character of sea-bottom, as affecting the species of marine fossils; also for geographical range and consequent climatic influences, especially in different latitudes, where the species of land plants may vary.

XVI.—The Ages, Periods, etc., are generally discussed in ascending order—the historical order of their development. Two names, each, are given to four of the ages in the left-hand column of the table in Note VIII., above—the one being geographical (except as to the Carboniferous), and the other derived from the organic remains prevailing in each age, respectively; for example, "Devonian, or Age of Fishes." The periods, of which there are *twenty* recognized by all American Geologists, have received various names—giving us what would be an unfortunate mixture, if they had not been so long in use as to have fixed the significance of each. So, also, the names of epochs or subdivisions of periods, though taken chiefly from the English, Canadian, and New York Surveys, have become a part of the language of American Geology.

The notation of the several periods by numbers, from 1 to 20, and of the epochs by letters attached to the same numbers, is sufficiently pliable to admit of variations or additions adapted to all local demands.

XVII.—*Changes of level* on the earth's surface have occurred at all periods of geological history; and are still going on, though at a greatly diminished rate. Such changes have sometimes resulted in the elevation of wide areas in one region, and a corresponding subsidence in others—thus accounting for the absence or presence of particular formations at certain points. In Central Alabama, for example, the periods 5a, 6, 7, 8, and 9 are wanting—caused, no doubt, by an elevation of this region above the sea-level, and the consequent prevention of the action here of those agencies which were at that time producing these formations farther north.

XVIII.—The alternate rising and sinking of the coal fields can alone account for the variety of rocky beds found in both the Sub-Carboniferous and the Carboniferous periods, and for the varying condition of the water in which the rocky beds as well as the coal beds were accumulated.

XIX.—*Chemical Geology* is, when treated in all its bearings, one of the widest and most important departments of science. But we shall limit what we have to say under this head to a few explanatory notes on the production of *limestones*, *iron ores* and *coals* among the stratified rocks.

It will be well to bear in mind in this connection that carbonic acid in water is the great solvent agent of carbonate of lime and carbonate of iron. The several soluble forms of decaying vegetable matter have also great solvent power, especially over oxide of iron. Some of these organic substances are also active deoxydizing agents.

XX.—Limestones have been accumulated at all periods of geological history, and are forming at the present day. The carbonate of lime, of which they are chiefly composed, has probably all been in solution in water at some period of its existence. Water combined with carbonic acid gas dissolves carbonate of lime freely. Hence the rain, which always brings down carbonic acid from the atmosphere, in percolating strata containing calcareous matter dissolves a portion of it, and thus forms limestone springs. When the water of such springs evaporates or loses its carbonic acid, the carbonate of lime is deposited either as tufa, marl, or calc spar. Such water, trickling through the roofs of caverns, produces stalactites and stalagmites. The quantity of carbonic acid that water can absorb is greatly increased (*cæteris paribus*) by pressure, and its solvent power over carbonate of lime is increased in a corresponding ratio. Hence subterranean waters, under pressure, dissolve large quantities of carbonate of lime, which is rapidly deposited as tufa when the pressure is removed and the water comes to the surface.

All running streams carry with them some carbonate of lime and mingle it with the waters of the ocean; it is, therefore, present in all sea water, from which it is gradually extracted for the construction of cells of coral and shells of molluscous animals.

Old coral reefs penetrated by calcareous water become petrified into coral limestone. In like manner, masses of molluscous shells are hardened and cemented into shell limestone. These chemical processes must have gone on very rapidly in the earlier geological periods, because of the great prevalence of carbonic acid in all the ages preceding the Carboniferous. Many of the bedded limestones are formed of the detritus of still older calcareous masses deposited as mud, or in fragments of various sizes, and subsequently hardened. When carbonate of magnesia is present, as is frequently the case in calcareous waters, rocks of a more or less dolomitic character are formed.

XXI.—Water in contact with decaying organic matter, such as leaves, grass, etc., becomes charged with soluble portions of the organic substances as well as carbonic acid. It then has the chemical power of deoxydizing the ferric oxide of red clays and sandstones, of changing it to carbonate of iron, and so carrying it off in solution. Water in this condition forms chalybeate springs, and on free exposure to the air has its carbonate of iron rapidly changed to hydrated ferric oxide, which we see as a reddish brown sediment along the streams issuing from such springs. If such water collects in low grounds or bogs, it frequently deposits large beds of the same oxide of iron mingled with clay, sand, and other impurities, forming *bog iron ore.* If a large excess of organic matter be present it prevents the oxidation and causes the iron to be deposited as carbonate, instead of ferric oxide. It may then accumulate in impure nodular masses or concretions, called *clay ironstone;* or in regularly stratified layers mingled with carbonaceous matter, when it forms the beds of *black-band ore* of the coal fields.

Where chalybeate waters accumulated in large volume for long periods of geological time, and over shallow sea-bottoms, they deposited some very extensive beds of hydrated ferric oxide, which have been subsequently much abraded and mixed with clay and sand, and now constitute the beds of limonite ores so abundant in this country. Some beds of limonité have doubtless been formed by the decomposition of pyrite, as the gossan of the copper lodes; but this alone could not produce the compact and somewhat fibrous nodules and stalactic forms of ore found in nearly all beds of limonite. These must be the result of solution in water and re-precipitation. The existence of masses and crystals of pyrite in beds of limonite ores by no means determines their original condition, as such forms of pyrite are found in nearly all kinds of mineral beds.

The Lower Silurian Age seems to have been especially favorable for the accumulation of this kind of ore, all along its range from Alabama to New York. The Clinton epoch (5 b) of the Niagara period was also favorable for the accumulation of ore; especially the red shale, the dye-stone and the red fossil ores, some one or all of which are found among its strata throughout the whole of the Appalachian

Range. In Virginia the Oriskany (8) was one of the great iron producing periods, but is wanting in Alabama.

Specular and red hematite ores differ from limonites only in having no combined water. They were probably deposited originally either in the hydrated form, and afterwards metamorphosed by heat, or at a temperature so high as to prevent hydration, as appears to be the case in the ores of Red Mountain. Magnetite is a combination of protoxide and peroxide of iron, and is easily prepared artificially by boiling together in water a mixed precipitate of these two oxides; or the carbonate may be substituted for the protoxide. Now, it frequently happens that the carbonate and peroxide of iron are both precipitated from chalybeate waters in the same locality. If, then, such a mixture were heated to the proper temperature, the result would be the expulsion of carbonic acid, and the combination of the two oxides as *Magnetite.* If the hydrated peroxide were in excess, a portion of it would be changed to specular ore. Such may be the origin of the beds of pure magnetite, as well as of the mixed ores (specular and magnetic) so often found imbedded among the metamorphic rocks.

XXII.—*The origin of Coal* is a subject of interest to all its intelligent consumers. That coal, in all its varieties, originated from vegetable matter accumulated in wide expanses of shallow inland seas or lakes, hardly admits of a doubt. This conclusion is demonstrated by the remains of plants found not only in contact with the beds of coal, but also incorporated with the coal itself.

The essential constituents of solid vegetable substances are carbon, hydrogen and oxygen, with a little nitrogen. When a mass of vegetable matter is left to decay in open air it becomes oxidized—or gradually consumed—and disappears in the form of carbonic acid, water and some ammonia, while only its mineral matter, or ash, is left behind.

Not so when the air is excluded by water or mud. No chemical agent like the oxygen of the air now acts upon the mass, but chemical changes take place among its own constituents—a different kind of decay now goes on. It loses some portions of all its elements, but less of the carbon than of the other substances. Part of the carbon escapes as carbonic acid gas, and part of the carbon and hydrogen unite to form the combustible and explosive marsh-gas so dangerous in coal mines. We have a good illustration of the chemical process by which vegetable matter (or woody fibre) is changed to coal, in peat, brown coal, or lignite. The same action, continued, would convert these into bituminous, semi-bituminous, or anthracite coal. These several forms of carbonaceous matter, or varieties of coal, at some points blend gradually into one another; but still there are large quantities of each kind forming distinct beds.

The following table shows their chemical relations. It will be seen that on the hypothesis of 100 parts of carbon being retained in each variety, the other elements decrease in a rapid ratio. The ashes are not taken into account:

	C.	H.	O.	N.
Wood	100	12	83.	1
Peat	100	10	56	2
Lignite	100	8	42	0.8
Bituminous Coal	100	6	21	0.8
Semi-bituminous Coal	100	3	11	0.5
Anthracite Coal	100	3	2	0
Graphite	100	0	0	0

The hydrogen and oxygen of coal are generally combined with a portion of the carbon as volatile, bituminous and oily substances readily expelled by heat.

Diamond is the purest form of carbon. *Graphite* (black lead) stands next. *Anthracite coal* generally has a little volatile matter, with 90 to 95 per cent. of fixed carbon. *Semi-bituminous coal* contains from 15 to 20 per cent. of volatile combustible matter, with 80 to 85 per cent. of fixed carbon. "These are free-burning, rapid-burning coals, producing long flame and high temperature because they do not cake and clog. They are well adapted to steam-engines, and hence called *steam coals.*" (Le Conte.)

Bituminous coals have from 30 to 50 per cent of volatile matter, and usually undergo more or less fusion when ignited. When burned in "ovens" or kilns constructed for the purpose, the volatile matter is expelled and the gray residuary mass is coke. A high temperature, continued for some time, is required to give coke proper compactness for use in the blast furnace. This is the class of coal found in greatest abundance in the Alabama coal fields. Fat coal is still more highly bituminous, and hence is valuable as a gas coal. Brown coal and lignite are less compact bituminous coals, found in geological formations more recent than the Carboniferous. Beds of lignite, supposed to be of tertiary age, are said to be extensive in the region of country bordering on the Mississippi River. Ashes of coal or coke are composed of the original mineral substances of the plants from which the coal was formed, together with such mineral impurities as were mechanically incorporated during its formation, except that the alkaline and calcareous substances have been in a great measure dissolved and carried away. The sulphur of coal is most frequently found in combination with iron as pyrite, but also exists in some forms of bituminous matter, and sometimes occurs as sulphate of lime. Except in the last case a large portion of the sulphur is expelled in coking. The presence of any considerable percentage of arsenic in coal, which sometimes occurs, may be retained by the coke in injurious quantities—if employed for working iron. In the manufacture of coal gas the nitrogen of the coal unites with hydrogen and carbonic acid, forming carbonate of ammonia, which is condensed in the gas works and becomes one of the chief sources of the commercial salts of ammonia.

Carbonate of ammonia, and other valuable substances, escape in large quantities from coke ovens. Means will no doubt, at some early day, be devised for catching and utilizing the vast quantities of valuable products that now go to waste in the coking process—among which, also, are both combustible gases and ammonia—and thus additional items of profit will be secured.

APPENDIX C.

SOME CHEMICAL NOTES.

I.—*The Chemical process* by which sulphuric acid is made from pyrites is both interesting and instructive. Every atom of sulphur burned out of the mineral takes up two atoms of oxygen from the air, forming the chemical compound indicated by SO_2. The two atoms of oxygen, thus added, weigh just as much as the one atom of sulphur, hence the resulting gas weighs twice as much as the sulphur consumed in its production. This gas, passed into the leaden chamber of the acid-works, takes an additional atom of oxygen from nitric oxide, also passed into the chamber, and which it would not take directly from the air. Thus another addition is made to the weight. At the same time, this compound of sulphur and oxygen comes in contact with the vapor of water constantly thrown into the chamber by steam jets, and at once combines with a portion of it and becomes sulphuric acid, which is absorbed by the excess of water always contained in the bottom of the chamber. An atom of sulphur thus converted into sulphuric acid is increased to a little more than three times its original weight by material furnished from air and water. This acid is represented by the formula H_2SO_4. Thus one ton of sulphur would make three of pure sulphuric acid, leaving about two per cent. of margin for waste. But pure sulphuric acid is not employed in the manufacture of fertilizers. The water of the chamber rapidly absorbs the acid, until it attains sufficient strength to be employed in making the super-phosphate of lime manufactured from the Charleston phosphates or from the bones of animals.

II.—In the works near Atlanta, the crushed phosphate is moistened with the acid as it passes through the mill, and both are ground together. The chemical action and friction cause the ground material to issue from the mill at a high temperature, which rapidly expels a large part of the surplus water of the acid, and dries the mass sufficiently for convenient handling and shipping.

III.—The sulphuric acid resulting from the above process weighs more than the crude pyrite from which the sulphur is obtained, while the phosphate loses but little of its original constituents. So that, leaving moisture out of account, the result is, in weight at least, equal, and perhaps superior, to the whole of the material consumed.

The treatment of phosphate of lime with sulphuric acid results in the production of super-phosphate of lime and sulphate of lime, or gypsum. The sulphuric acid takes from the original insoluble phosphate two-thirds of its lime, and thus renders it soluble; while the lime extracted unites with the sulphuric acid and forms gypsum. This mixture is said to contain from twenty to twenty-five per cent. of phosphoric acid. It contains fertilizing constituents, all of which are wanted in soils that have been long under cultivation. With the addition of ammonia salts, it is well adapted to the metamorphic soils of Georgia and Alabama; and with the still farther addition of wood ashes or of potassa salts, it would contain what is most wanted in the exhausted soils of the limestone valleys farther west.

IV.—In the process of burning sulphur from iron pyrites, there is a mass of oxide of iron produced, equal in weight to more than half the pyrite employed. This oxide still retains a considerable percentage of sulphur, but is said to make iron suitable for castings requiring but little tenacity in their material. An admixture of manganiferous ore with this oxide would in all probability remove the greater part of its sulphur with the slag.

V.—The *Metallurgy of iron* is of so much interest and importance, in connection with the material employed in blast furnaces, as to call for a few notes on this subject.

The injurious impurities found in iron are chiefly sulphur and phosphorus, with titanium occasionally derived from magnetic ores. *Sulphur* imparts to iron the property known as *red-shortness.* Any considerable quantity of it in bar-iron, therefore, renders it unfit for hammering, rolling or welding. *Phosphorus* causes what is known as *cold-shortness*, that is, renders iron brittle, whether in its cast or in its wrought form. When it exists, however, in very small quantities, the phosphorus is said to harden the iron without seriously impairing its tenacity. In this case the proportion must be less than five-tenths of one per centum. *Titanium*, in any considerable quantity, renders iron unduly hard and brittle.

VI.—The *fuel* for the reduction of iron, whether charcoal or coke, is chiefly carbon. Charcoal has the advantage of greater purity, being practically free from both sulphur and phosphorus. Coke has the advantage of greater compactness and strength, and hence has greater heating power, and more ability to sustain the burden of the charge in a large furnace. But nearly all coke contains sulphur, and sometimes phosphorus, though the latter is generally in such combination as to go off with the slag. The charge of the furnace consists of a mixture of fuel, ore and limestone, in proportions varying considerably with the different varieties of ore. The fuel serves two leading purposes, (1) the production of the requisite amount of heat; (2) the deoxidation of the ore. The iron is not deoxidized by the carbon in its solid form, but by carbonic oxide CO, or half burnt carbon, generated by air from the tuyeres passing through the red hot fuel in the lower part of the stack. This gas penetrates the hot ore at higher points, and having a strong affinity for oxygen takes that element from the ore—thus becoming CO_2, or fully burnt carbon. This is carbonic acid gas. The iron thus deprived of its oxygen descends to a lower and hotter part of the furnace, where it takes up from three to five per cent. of carbon with some silicon from sand, and becoming quite fusible sinks to the bottom of the crucible, or furnace hearth. In the meantime the lime unites with the clay and silica of the ore, forming a fusible slag, which runs down with the melted iron into the crucible; on account of its lower specific gravity, it there floats on the surface of the molten iron, from which it is drawn off from time to time.

The slag is an essential product of the furnace, and its fusibility is a point of great importance. The impurities of the ore, removed by it, are principally sand and clay, which unite with the lime and magnesia of the limestones and form a complex silicate of lime, magnesia and alumina that is quite fusible. Very silicious ores require large quantities of limestone, and produce slags difficult of fusion, while the presence of a large percentage of alumina gives the slag a much higher degree of fusibility. Hence the advantage of mixing silicious and argillaceous ores in the furnace. Silicious ores are worked to better advantage by the addition of some argillaceous ore, even when the latter is too lean to be profitably worked alone. Argillaceous limestones are sometimes advantageously employed with silicious ores. Magnesian limestones are said to be the best for very pure argillaceous ores.

VII.—*Manganese*, in small quantity, is thought by many manufacturers to improve the quality of both iron and steel by increasing their hardness and tenacity. "It has been observed that the cinder from iron smelted from manganiferous ores contains, generally speaking, more sulphur than slags or cinders from iron ores containing no manganese. We have had numerous opportunities of confirming this, and have, therefore, on this account alone, attached much importance to the existence of manganese in iron ores." [Ure's Dictionary, Supp.]

The *Bessemer process* consists essentially in putting several tons of melted pig iron into a large crucible constructed for the purpose, and passing hot air through the liquid mass till the carbon and silicon have been burned out. It is then called refined iron. A quantity of spiegeleisen is now added to convert the mass into steel. German spiegeleisen has the following composition: Pure Iron, 82.85 per cent.; Manganese, 10.71; Carbon, 4.32; Silicon, 1; Phosphorus, a *trace*. The objects of its use in the Bessemer process of making steel are threefold: (1) to restore to the refined iron the requisite amount of carbon for steel; (2) to communicate a small quantity of manganese metal to the steel; (3) to carry off as slag any sulphur that may be left in the iron after the first refining process.

THE GEORGIA PACIFIC RAILWAY.

This Road is an extension of the Richmond & Danville System. Its line, as located and partly completed, extends from Atlanta, the Capital of Georgia, directly westward through Anniston and Birmingham, Alabama, to Columbus, Mississippi; and thence either to Greenville, on the Mississippi River, or to Arkansas City, higher up. From its point of crossing it may have additional lines of extension into Texas, and finally to the Pacific Coast. Reference to the accompanying map will throw light upon what is said below.

ITS LOCATION AND CONNECTIONS.

As stated above, the Georgia Pacific Railway is an extension of the Richmond & Danville system, which has 2,229 miles of road now in operation, and traverses the States of Virginia, North Carolina, South Carolina and Georgia, in such a way as to connect their most important points with Washington, Baltimore, Philadelphia and New York. To this system the Georgia Pacific Railway, with its branches, when completed, will add 700 miles; and, as shown in the foregoing Report of Messrs. Campbell and Ruffner, will open up a region of country exceedingly rich in mineral, forest and agricultural resources, a large proportion of which has hitherto been without even the ordinary facilities for transportation.

RAILROAD CONNECTIONS.

At Atlanta, the Georgia Pacific connects with the Atlanta &

Charlotte Air Line, which is the southwestern arm of the Richmond & Danville system. At this important point it also connects with the Western & Atlantic, the Cincinnati & Georgia, the Georgia Central, the Atlanta & West Point and Georgia railroads, thus constituting the only direct Western line, and the shortest line to New Orleans and all Southwestern points.

At the new and flourishing little city of Anniston, about 100 miles west of Atlanta, it crosses the Selma, Rome & Dalton R. R.—the main stem of the East Tennessee, Virginia & Georgia system. The distance from either Anniston or Oxford to Atlanta, by the Georgia Pacific Railway, is about 40 miles shorter than by any other route.

At Birmingham, the Pittsburg of the South 66 miles farther west, it crosses both the Alabama Great Southern and the Louisville & Nashville roads. Through these lines the Georgia Pacific will have direct communication with Nashville, Louisville, Cincinnati, and other important cities on the north; and with Montgomery, Mobile, New Orleans, and other important places on the south. This new road offers a route from Birmingham to Atlanta 100 miles shorter than by any other line.

At Columbus, Miss., 290 miles west of Atlanta, and 125 miles west of Birmingham, this line connects with the Artesia branch of the Mobile & Ohio Railway, and reaches the main stem of that road near Artesia, 300 miles from Atlanta, thus securing another connection with Mobile. At Starkville, 310 miles from Atlanta, it will cross the road now being built from Aberdeen to Kosciusko Junction, on the Chicago, St. Louis & New Orleans R. R., and will cross the last named road at Winona, 375 miles from Atlanta—thus making two important connections with New Orleans. From Winona to Atlanta by any competing route is about 520 miles.

At Arkansas City, west of the Mississippi River, and 460 miles from Atlanta, it will connect with a completed system of roads running northwest, through Little Rock, to Fort Smith on the border of the Indian Territory, from which point a line is projected to Fort Gibson, on the Missouri, Kansas & Texas R. R., thus affording the shortest and best line of transportation between the grain-growing region of Kansas and the Northwest, on the one hand, and the markets of the South Atlantic and Gulf States on the other.

At Texarkana, 650 miles west of Atlanta, the Georgia Pacific will connect with the Southwestern system of roads, and thus give the Richmond & Danville system, with all the points reached by it, the best and most direct line to the Southwestern States, Mexico, and the Southern Pacific Slope.

RIVER CONNECTIONS.

The several river connections of the Georgia Pacific Railway are important, and will become more so when their navigation is improved. The first of these rivers is the Coosa, which is navigable from Rome, Georgia, to Central Alabama, and traverses the Great Silurian Valley with its extensive beds of limestone and iron ores. Improvements are now in process, under governmental patronage, for making this stream navigable. These improvements, when completed, will open navigation for steamers from Rome to the point at which the railway line crosses the river.

West of Birmingham the route crosses the Black Warrior, which can be rendered available for the transportation of coal and lumber as soon as railroad transportation shall afford a convenient and cheap outlet to market.

After passing into Mississippi the line crosses the Tombigbee River near Columbus, where it will secure the large local traffic of this river, and through it will have an outlet by steamers to the coal markets of Mobile and other cities, and to the coaling stations along the Gulf Coast.

The Yazoo and Sunflower are the most important rivers of the great Yazoo Delta, and are navigable above and below the point where the railway line crosses them. These streams will also contribute a large local travel and traffic to the Railway, and will open new and important markets for the coals which it will bring out from the Great Warrior Field.

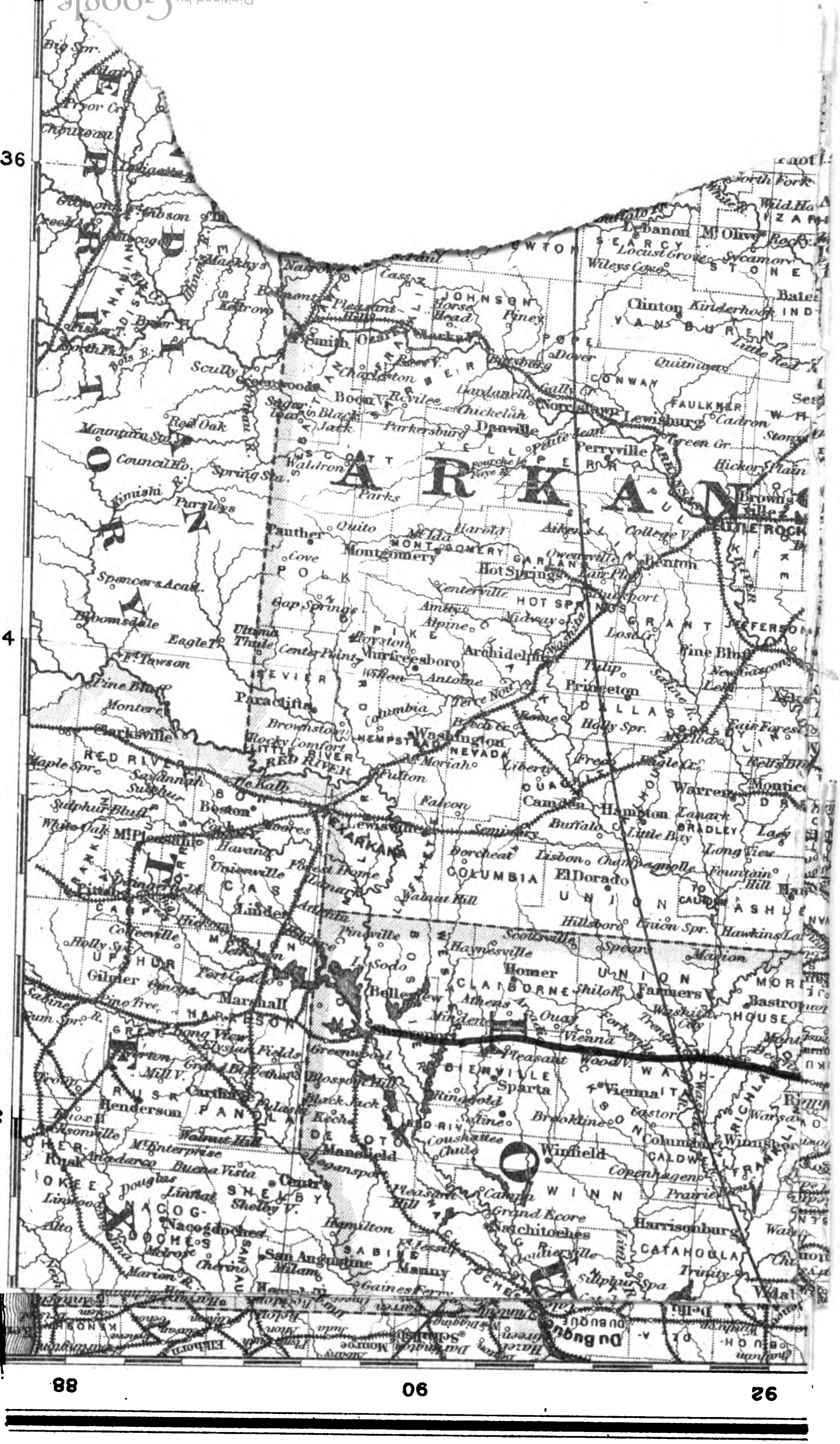
The point at which the Georgia Pacific Railway will reach the Mississippi River will be one of great interest and importance. A market for coal and lumber, as well as for cotton, iron and other industrial products, must spring up here. The river will be brought within easy reach of the mines of the Warrior Coal Field, from which coal can certainly be brought at a cost far below the present price, and with far greater certainty of keeping up a constant supply. This, therefore, will be the line through which much of the enormous demand for coal on the river, for consumption on steamboats, in gas works, sugar houses and factories of various kinds, will be met in future.

The importance of this extensive through line, with its numerous railroad and river connections, will be seen at once by a glance at the map; but will be more fully appreciated when we take also into view the vast forests, and mineral and agricultural regions it will penetrate, and the numerous and varied industrial enterprises that will contribute to its tonnage, when completed.

THE GEORGIA PACIFIC RAILWAY COMPANY,
No. 20 Nassau St,
New York.

May 1, 1883.

UNIV. OF MICH.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El Dorado
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JEFFERSON
Pine Bluff
Princeton
Arkadelphia
Murfreesboro
Paraclifta
LITTLE RIVER
RED RIVER
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Fulton
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Jefferson
Marshall
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San Augustine
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CALDWELL
Columbia
Harrisonburg
CATAHOULA
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Dardanelle
Danville
YELL
PERRY
Perryville
SCOTT
Waldron
Fort Smith
Ozark
JOHNSON
POPE
Dover
CONWAY
FAULKNER
Lewisburg
VAN BUREN
Clinton
SEARCY
STONE
Lebanon
Mt Olive
IND. TERRITORY
Doaksville
Ft Towson
Eagle T.
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Greenwood
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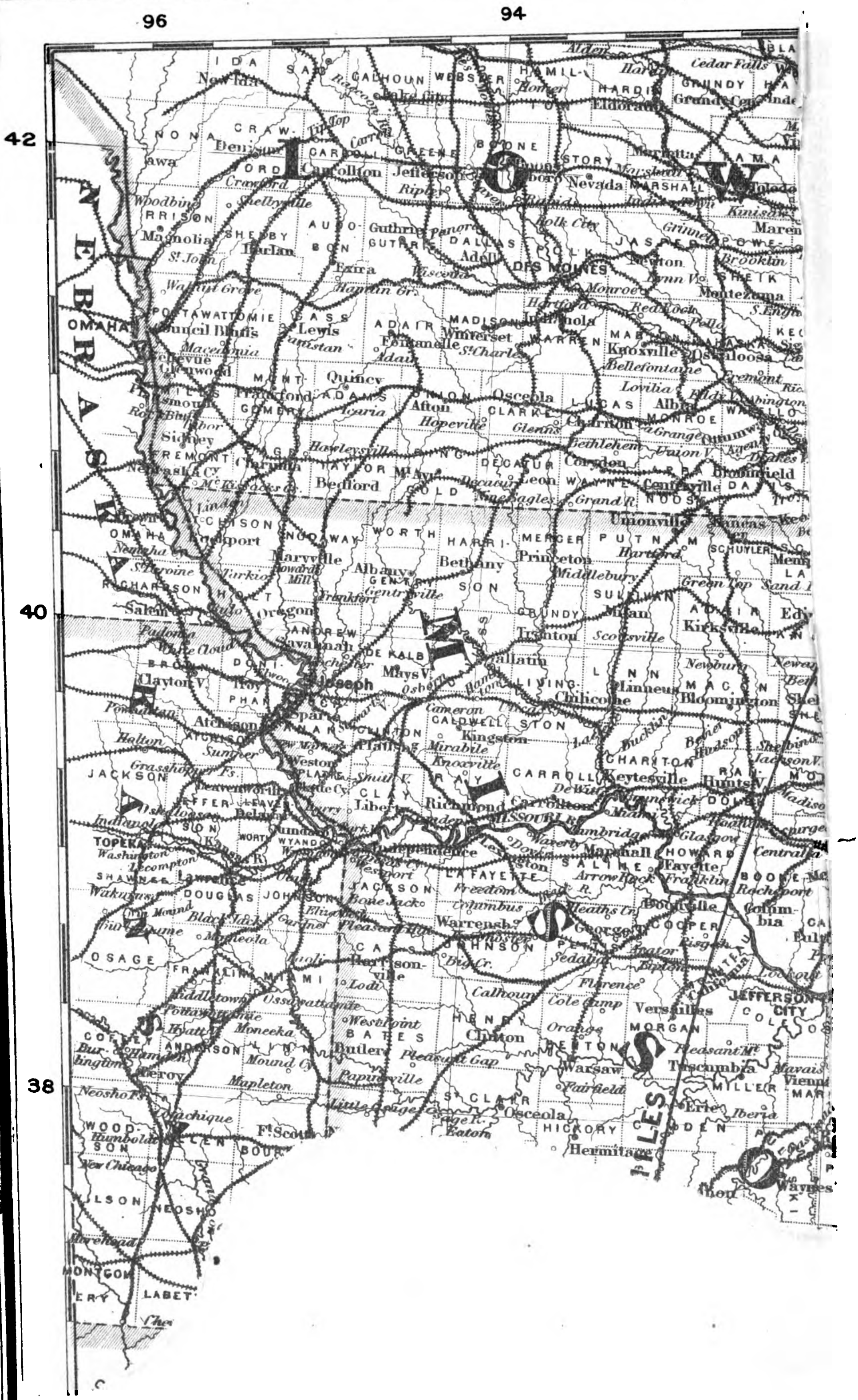
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Cedar Falls
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Eldora
Grundy Centre
Lake City
Raccoon R.
CRAWFORD
Denison
CARROLL
Carrollton
GREENE
Jefferson
BOONE
STORY
Nevada
Marshalltown
MARSHALL
TAMA
Toledo
Kinisaw
Crawford
Shelbyville
Ripley
Boonsboro
Woodbine
HARRISON
Magnolia
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AUDUBON
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DALLAS
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Polk City
DES MOINES
JASPER
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Grinnell
POWESHIEK
Brooklin
Montezuma
St. John
Exira
Hamlin Gr.
Walnut Grove
Monroe
Hartford
Red Rock
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POTTAWATTOMIE
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Grant
ADAIR
Fontanelle
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MADISON
Winterset
St. Charles
Indianola
WARREN
MARION
Knoxville
MAHASKA
Oskaloosa
OMAHA
Council Bluffs
Macedonia
Bellevue
Glenwood
Bellefontaine
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Frankfort
Quincy
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CLARKE
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Lovilia
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Plattsmouth
Rock Bluff
Tabor
Sidney
Hopeville
Glenns
Chariton
MONROE
La Grange
FREMONT
Clarinda
PAGE
Hawleysville
TAYLOR
Bedford
RINGGOLD
Mt. Ayr
DECATUR
Decatur
Leon
WAYNE
Corydon
Bethlehem
Union V.
APPANOOSE
Centreville
Bloomfield
DAVIS
Nebraska Cy.
Lindon
McKissacks Gr.
Nine Eagles
Grand R.
Unionville
ATCHISON
Rockport
NODAWAY
Maryville
WORTH
HARRISON
Bethany
MERCER
Princeton
PUTNAM
Hartford
SCHUYLER
Memphis
Middlebury
Green Top
Howards Mill
Tarkio
Albany
GENTRY
Gentryville
SULLIVAN
Milan
ADAIR
Kirksville
OMAHA
Nemaha Cy.
St. Deroine
RICHARDSON
HOLT
Oregon
Forest City
Salem
GRUNDY
Trenton
Scottsville
ANDREW
Savannah
Falls City
White Cloud
DE KALB
Maysville
Gallatin
DAVIESS
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Newburg
MACON
Bloomington
Shelbyville
BROWN
Clayton V.
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Troy
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St. Joseph
Osborn
Hamilton
LIVINGSTON
Chillicothe
Powhattan
Atchison
Sparta
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CLINTON
Plattsburg
Cameron
CALDWELL
Kingston
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Bucklin
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Jackson V.
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Lexington
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Cambridge
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HOWARD
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Centralia
Westport
SALINE
Arrow Rock
Franklin
BOONE
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Lone Jack
LAFAYETTE
Freedom
Dover
Columbus
Heaths Cr.
Boonville
Columbia
Callaway
Fulton
Burlingame
Prairie City
Black Jack
Gardner
Elizabeth
Pleasant Hill
Warrensburg
JOHNSON
Georgetown
COOPER
Pisgah
OSAGE
Minneola
Paola
CASS
Harrisonville
Big Cr.
Sedalia
PETTIS
Otterville
Tipton
MONITEAU
California
Lookout
FRANKLIN
MIAMI
Lodi
Calhoun
Florence
Cole Camp
Versailles
JEFFERSON CITY
COLE
Middletown
Pottawatomie
Osawatomie
West Point
BATES
HENRY
Clinton
Orange
MORGAN
Pleasant Mt.
Tuscumbia
Hyatt
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COFFEY
Burlington
Hampden
ANDERSON
LINN
Mound Cy.
Butler
Pleasant Gap
BENTON
Warsaw
MILLER
Marais
Vienna
MARIES
Leroy
Mapleton
Papinsville
Neosho Fs.
Little Osage
Osage R.
ST. CLAIR
Osceola
Eaton
Fairfield
Erie
Iberia
WOODSON
Humboldt
Cofachique
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